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THE ELECTRICAL PRODUCTION OF OZONE.

IN recent years considerable attention has been devoted by electricians and chemists to the production of ozone by electricity, but very little has been done to produce this gas on a large scale for commercial purposes, although its utility for various industrial uses has long been known. One of the reasons, and perhaps the most important for the want of development in the employment of ozone, has been the great difficulty of preparation, but this disadvantage now appears to have been overcome both in France and in England. In the former country MM. Broyet and Petit recently introduced an electro-chemical process, by means of which ozone was obtained from oxygen. The oxygen is pumped out of a reservoir, and dried by being passed through chloride of calcium. It then enters the ozonising apparatus, which consists of a series of tubes, in each of which are placed two aluminium spirals. A small dynamo excites a current in induction coils, corresponding in number to that of the tubes, and the coils are connected to the aluminium spirals. Thus on the oxygen passing through the tubes, which action takes places successively, the electrical discharges produced between the spirals transforms the oxygen into ozone, which can then be stored in a reservoir. This method is already in operation in a brewery at Tournus, where the ozone is used to impart age to alcohol, of which it oxidises the principal oils.

It is said that a company to work a somewhat similar process in this country will, in a few months' time, be brought out. This method has been invented by Mr. Ernst Fahrig, of St. Helen's Ozone Works, Plaistow, already made known in our correspondence columns. A demonstration of the system was recently given, but as the English and foreign patents have not yet been fully secured, we are unable to give more than a brief notice. The process differs from that of MM. Broyet and Petit, in so far as the ozone is produced from the atmospheric air, and not direct from oxygen. The air is drawn into a vertical pipe by means of a blower, and from thence it enters a sterilising apparatus. It is then expanded and compressed in various pipes until it reaches the ozonising apparatus proper. The latter consists of three cases, through which an alternating current of 10 ampères is passed, and this causes blue sparks to occur—probably in the same manner as in the first-mentioned process—thus producing ozone. The details of the invention are kept secret, a fact which leads to the opinion that there is something wrong with the process. Several ozonised products obtained at the works were shown, such as esparto pulp bleached by the ozone, ozonised water for sterilising purposes, ozonised oil for use in medicine, and in the manufacture of floorcloth and linoleum, bleached solutions of sugar, &c.

Up to the present, however, Mr. Fahrig does not seem to have accomplished anything to lead us to pin our faith on his *bonâ fides*.

LIGHTNING PROTECTORS.

THE recent paper by Professor Oliver J. Lodge, read before the Institution of Electrical Engineers, and the discussion on the same, though bringing the subject of lightning protectors prominently forward leaves the question of protecting lines in pretty much the position it has hitherto occupied. Prof. Lodge's contention was that the present system of protectors (for telegraphic circuits) was shown by theory and practice to be insufficient; but the evidence that he brought forward to prove this was somewhat feeble; indeed it is difficult to see how anyone so entirely out of the groove of practical telegraphy as the Professor could speak with much authority on the subject. His suggestion that certain faults in submarine cables whose cause was unknown might be due to lightning would have a certain amount of force if such faults existed; but we fear they exist only in imagination, and this

being the case, we cannot accept them as proof that the present means of protection is unreliable. As a matter of fact, as was pointed out by Mr. Preece, there are in the postal system 117 cables, and in only one single instance has there been a case where lightning might have produced a fault, and in that instance it was very doubtful whether lightning had actually anything to do with the defect. The cables, it should be mentioned, are in almost all cases directly connected with lengths of aerial line, so that lightning has every chance to enter the cables to which these open wires are connected. That lightning does strike the wires, and that the protectors answer the purpose of drawing off the discharge, there is ample evidence to prove, as the protectors are examined monthly, and signs of a discharge having taken place are often discovered. Again, Mr. Preece pointed out that in no single case where fast-speed instruments have been used on long circuits (these being the most important lines) has there been a single case of damage by lightning, the instruments being all guarded by protectors. In cases where failures to protect have occurred, there has been no evidence to prove that they were not due to a hidden defect in the protector itself, rather than to a defect in its design. The evidence of Mr. Saunders, of the Eastern Telegraph Company, that gentleman having 50,000 miles of cable under his charge, was also to the effect that the present form of protector was perfectly efficient. It is obvious, then, that the protectors in use are not nearly so bad as Prof. Lodge thinks, and though the evidence as regards India seemed to show that they were not always efficient, it remains to be seen if Prof. Lodge's amended form when applied in practice to the experience of a heavy lightning stroke, and not that of the lilliputian spark generated in a laboratory, will prove as efficient as imagined. Unfortunately, very much of the evidence as regards damage by lightning is of a negative character, and it would probably take years to decide whether the new protector is better than the old one. There is, no doubt, much of value in the carefully carried out experiments of Prof. Lodge; but, in the face of the experience of practical men, who are often virtually told that they don't know their own business, we are inclined to say that taken all round as regards safety, reliability and cheapness, the forms of protectors now in use will be found hard to beat. Of course this does not detract in the least from the credit due to Prof. Lodge for having shown theoretically how lines are protected from lightning by earth shunts with air gaps. It is simply because the enormous impedance offered in the case of lightning discharges renders the resistance of the line comparable with that of the air gap itself.

The Gas Engine Free.

THE patent for the "Otto" gas engine, according to a statement in the *Gas World*, expires to-morrow. Broken down in Germany, France and the United States, it has successfully held its position here in spite of all opposition. Our contemporary considers, and we think with every reason, that the Otto patent has been an incubus on the gas industry and that energy and enterprise have thereby been stifled during the past 14 years. The excessive prices charged for the engines have also excluded the employment of gas as a motive power in numbers of instances, but now the monopoly has practically come to an end, and many inventors and manufacturers are only awaiting the moment when the patent legally lapses to enter the vast field which will then lie open to them. There is little doubt but that this freedom from a harassing patent will be the indirect means of largely increasing the demand for private electric lighting plants, and we shall always be pleased to bring before the notice of our readers any promising engine likely to prove useful; for it is certain that a well regulated gas motor is quite capable of giving every satisfaction.

How Electric Lighting is Carried Out.

LAST month Mr. Frank M. Gilley read a paper before the Massachusetts Society of Arts on "Central Electric Lighting Stations of London." There is nothing in his description of the work being done in the Metropolis, but his concluding paragraph may interest those who have control of the lighting arrangements:—"The quality of incandescent light in London is inferior. The light is not steady, never above candle-power, but of a dull red colour, and is often referred to by envious gas engineers as 4-watt red-hot hairpins. The expert, the bane of all electric companies in the United States, has a cousin in the engineer. They are of the same class as the experts, only they know less. The height of their ambition is to become 'attached' to the staff of some noted engineer, and superintend or direct practical work without ever learning it by hard work and experience. Engine drivers earn 30s. a week; they are little more than oilers; fitters keep machines in repair; steam engineers overlook all this work; the engineers of the staff oversee the steam engineers and the engineers-in-chief receive the salary and get the honours. Manual labour is deemed menial, and young men of the middle class shun it."

A Sudden Awakening.

AN estimable contemporary is progressing—backwards. It frequently publishes stale information, but the latest is the important discovery just made by its Brussels correspondent that the Julien cars have ceased running in that city, a statement made in the REVIEW some weeks ago. It is also odd to read that the cars were started "a short time ago," when they were really placed upon the line four years since.

Going Abroad for News.

WE are getting accustomed to reading foreign journals to ascertain facts (!) regarding English electrical undertakings, but we find in the last issue of the *Railway Press* a rather startling announcement. In the course of an article on the "Electric Cars of the Future," our contemporary states:—"In a few days we shall see the opening of the London and Southwark Railway, to be followed by the far more important undertaking known as the Central Railway." This may be a pleasant sur-

prise for the shareholders of the former railway, but unfortunately the assertion has no foundation in fact. Only two of the stations are complete, and the other four are making very slow progress, whilst the cars and locomotives are only in course of construction. As far as can be seen at present, if the railway is opened this year it will be nothing short of a miracle. In the latter portion of the article referred to, the *Railway Press* goes into ecstasy regarding the Wynne system of electric traction, which is almost predicted to be the system of the future, and of which our contemporary has just discovered the existence.

A Pardonable Error.

WHEN we saw the announcement that Messrs. W. T. Goolden & Co. were defendants in an action brought against them by the company owning the Sphincter Grip armoured hose, thoughts of the most varied nature teemed in our over-wrought brain. To a connoisseur of the female form divine, nothing is more inelegant than badly-fitting stockings; but what, thought we, can Messrs. Goolden want with hose which grip? On a more careful perusal of the note which filled us with these misgivings, we found, much to our relief, that the article which we had mistaken for another, was simply intended to be fixed to some steam flanges in the defendants' works.

The Belt Case.

OUR readers are not to suppose that we are alluding to that famous *cause célèbre* which took place some years ago in artistic circles; we only wish to remark that in the Royal Academy Exhibition there may be seen a bust of that illustrious *savant* the President of the British Association of Medical Electricians, the work of a grateful patient.

The Thomson-Houston Electric Company.

THE returns of this great organisation are always read with interest by those financially and otherwise interested in the development of electric lighting. The following table shows the number of American companies using the Thomson-Houston arc and incandescent systems and their rapid development within the last few years :—

Years.	Companies.	Arc Lamps.
1883	5	365
1889	419	51,621
1890	587	68,203

In addition to these, over 400 companies are operating 400,000 lights on the incandescent principle, while of many hundred isolated plants installed in factories, hotels, &c., throughout the States, no note is taken whatever. The offspring of the company is extremely large and claims companies operating its system in England, Italy, Sweden, South and Central America, France, Germany, Spain, Russia, Japan, West Indies, Australia, and throughout every civilised country in the world; it is, however, in the power department that the most interesting figures are shown, for although operating electric railways for two years only, it has resulted in 100 lines being under contract and in operation, making a total aggregation of 1,000 cars, which, taking into account the short period, is truly wonderful. Of course, such figures as to work done, must result in a satisfactory financial state, and the report shows that the annual business has increased from £60,000 in 1883 to £1,600,000 in 1889. Such returns are things we must dream of for a while in merry England.

Novelties in Dynamos.

WE have before us the drawings of a new dynamo made by Mr. G. E. Dorman, of Stafford, the advantages claimed for which are the shortening of the magnetic circuit, the reduction of leakage and the surrounding of the armature by the magnetising coils. As long ago as 1879 M. Gramme designed a field magnet consisting of an oval ring with two limbs projecting inwards, upon which the magnetising coils were placed. These limbs were fitted with pole pieces and the armature rotated between their bored faces, the arrangement forming really a single magnet with a divided yoke. Mr. Dorman's machine is pretty much the same only that the yoke ring is circular and the internal limbs have no pole pieces. But instead of a single coil being placed on each limb as in Gramme's machine, there is here a number of thin flat coils of decreasing widths placed one above the other and bent into circular form to fit the curvature of the yoke ring. The coil put on first is close to this ring and the one put on last is close to and surrounding the armature. These coils have such widths that when bent into shape the edges of those on opposite limbs butt together, the whole of the interior space, other than that occupied by the armature, being thus occupied by wire through which a current flows. It is obvious that the arrangement forms a sort of electrical furnace, since the precautions against leakage of heat are as carefully taken as those against leakage of magnetism. So far we do not see wherein lies the improvement, and there are certainly worse things in dynamos than waste field, as Mr. Dorman may eventually discover.

Primary Batteries.

IN a recent leaderette we referred to the Edison-Lalande battery; now reports from users appear to confirm the satisfactory character of the combination. On the Pensylvania railroad 56 cells are used for working 16 circuits, and the results are said to be excellent. The cells are stated to be far cheaper than the Callaud or gravity battery, which we can quite believe, as the latter is notoriously wasteful. If accounts are to be trusted, the Edison-Lalande cell appears to be a real advance in the matter of primary batteries.

A Little Knowledge, &c.

MR. C. B. HARNESS is once more displaying a gross ignorance of the subject with which he is identified, this time in a pamphlet on "The Efficacy of Mild Galvanic Currents as Generated by Wearing the Electropathic Belt." What will be thought of the following :—"Suppose, for example, a patient were submitted for five minutes to a current of 15 milliampères, a space of time which could not be exceeded without producing upon the skin of the subject the phenomenon known as electrolytic eschar, during such five minutes there will have been a passage of 4,500 *milliampères*. Suppose now a pile of feeble delivery, excited by the skin, giving 1 milliampère; the application of this pile having a duration of 10 hours there will be a passage of 36,000 *milliampères*, which will have been absorbed by the

wearer progressively and without the least discomfort by adopting our method of application." And of the following :—"Thus indicating a *resistance* of 12 milliampères ;" the latter, we should mention, is not a solitary quotation, but is repeated in substance several times. Finally, we have the statement that the belt will give a current (not *resistance* this time) of $190\frac{1}{1000}$th *ampères* ! ! ! Can ignorance be more grossly displayed than in this manner ?

The Queen's Cable.

THE verdict given in the case of the Attorney-General *v.* Taylor, which may be seen in our Notes columns, seems to be an eminently sensible one. It is a great hardship for the toiling mariner to be charged with negligent navigation just because the Postal Authorities chose to lay the cable in the Medina river in an undefined position. We wish all juries would show similar sense in the execution of their duties.

Fire Rules, &c.

THE compilation by George H. Benjamin, of New York, of a set of rules which should be observed in employing electric currents for use in electric lighting, transmission of power, telegraphy, and kindred uses, appears to be a digest of the rules issued by the various Institutes of Electrical Engineers, Boards of Trade, fire underwriters, &c., of Europe and America. It consists of 69 clauses, and covers all requirements necessary for the safe usage of every kind of current, from a low pressure supply to that which the author calls the extra high pressure, having an electromotive force of over 3,000 volts. We agree with Mr. Benjamin that conductors conveying electric currents should be placed in plain sight, where any change in their condition can be noted at once, and that hidden electric leads are like unto hidden plumbing with all its attendant scamping and bad jointing, and we endorse his opinion that the first consideration on the part of a contractor is to make the circuit safe, and that no false economy should be allowed to interfere with the work being done in the best manner, and that every possible means should be taken to minimise the risk to human life and valuable property.

Hails from America.

THE latest triumph of electrical science is the electrical hair-curler and, says the advertisement, like the majority of the marvellous electrical appliances which have been invented of recent years, it hails from America. By its aid the hair, beard, or moustache can be curled in any style in two minutes. We would recommend some sculptor of renown to try the article, and if successful, that he should chisel a bust of the inventor and exhibit it in the Royal Academy by the side of the classic features of the eminent medical electrician, who measures the resistance of his patients in milliampères.

American Patents.

IT may be of interest to our readers to know that a final and definite decision has just been given by the Supreme Court of the United States of America upon the authoritative interpretation of a clause in the Revised Statutes of 1870, defining the term of expiration of United States patents, as limited by the lapse of prior granted Foreign patents. It is usual with the English inventor to take advantage of provisional protection under the Patent Acts of Great Britain, and to apply for protection at an early stage of his invention. Subsequently he finds his hands forced by the completion of his British patent, to apply for protection in Foreign countries before publication of his British patent. As the United States patent is examined and reported upon officially, the allowance and issue can seldom be obtained before many months from the date of application, and the patent finally bears the date of issue. As, on the other hand, many Foreign patents are granted within a few months from their application, it is difficult to prevent the United States patent from being granted later than those of many other countries. It has hitherto been a matter of grave doubt, by reason of the decisions of certain United States Circuit Judges, whether the United States patent does not lapse with the failure to maintain any one of the prior Foreign patents by omission to pay the prescribed taxes (usually annual), or to conform to the requirements regarding the working of the various patents. The Supreme Court of the United States of America has now stated :—"There is nothing in the Statute which admits of the view that the duration of the United States patent is to be limited by anything but the duration of the *legal term* of the foreign patent in force at the time of the issuing of the United States patent, or that it is to limited by any lapsing or forfeiture of any portion of the term of such foreign patent, by means of the operation of a *condition subsequent* according to the Foreign Statute." And further :—"The Statute manifestly assumes that the patent previously granted in a foreign country is one granted for a definite term, and its meaning is that the United States patent shall be so limited as to expire at the same time with such term of the Foreign patent." It is estimated that this decision will have conferred absolute validity upon United States patents to the value of many millions of dollars, as to which there was good reason, previously, to consider them as having expired.

Rivals in the Field.

THE London and the Westminster Electric Supply Corporations have powers in the same district, and the latter seems to possess some cause for complaint against the method of procedure adopted by its rival. It appears that the first-named has been sending circulars to those residents who are likely to become consumers, the main inducement of the Corporation being that it is ready to supply electrical energy almost immediately, the insinuation being that the Westminster Company is not yet in a position to commence operations. Naturally if householders are entrapped into signing a yearly agreement with the London Corporation on this plea, the others do not stand much chance of competing.

The Lane-Fox Patent.

As some misapprehension appears to exist in some quarters as to the nature of the claim of Mr. Lane-Fox's patent, No. 3,988**, of 1878, we would advise all those interested to procure a copy of the specification. The claim, however, runs as follows :—"The employment as described of secondary batteries as reservoirs of electricity, in combination with a mode or system of distribution such as is hereinbefore explained." Can any of our readers point to an example of accumulators being used in this manner previous to the date of the above-mentioned patent ?

ON THE EXCITEMENT OF ELECTRICITY AND HEAT IN ELECTROLYTES.

By MAX PLANCK (*Annalen der Physik und Chemie*).

(*Continued from page* 486.)

Section 6.--Limitation to One Spacial Co-ordinate.

THE equations are considerably simplified if we assume all the variables of y and z as independent; we will also in the sequel always suppose that the solution extends from $x = -\infty$ to $x = +\infty$. The equation (9) can then be integrated after x, and we have:—

$$(U + V)\frac{\delta \phi}{\delta x} + \frac{R}{\varepsilon}\frac{\delta (U - V)}{dx} = f(t).$$

The integration constant, $f(t)$, has a simple meaning, since, according to equation (3), it is:

$$-\varepsilon\left\{\frac{\delta (U - V)}{\delta x} + \frac{\varepsilon}{R}(U + V)\frac{\delta \phi}{\delta x}\right\} = J = -\frac{\varepsilon^2}{R}\cdot f(t),$$

wherein J signifies the density of the current passing through the solution, positive when the current flows in the direction of the increasing x. This current must therefore be the same at all places of the solution, and may vary only with the time. Let us assume that a given constant current is passed through the solution; J is then constant, and

$$(U + V)\frac{\delta \phi}{\delta x} + \frac{R}{\varepsilon}\frac{\delta (U - V)}{\delta x} + \frac{R}{\varepsilon^2}J = 0.$$

The value of $\delta \phi / \delta x$ thus derived is to be introduced into the general equations of movement (5) and (6), whereby the entire process is unequivocally determined whatever may be its given initial condition.

For $J = 0$ the potential decline in the solution is:

$$-\frac{\delta \phi}{\delta x} = \frac{R}{\varepsilon}\cdot\frac{\frac{\delta (U - V)}{\delta x}}{U + V} \qquad (12)$$

see equation (4) above.

Section 7.—Solution of a Single Electrolyte.

The equations of movement take an especially simple form in the case of a single electrolyte, consisting of a negative and a positive ion. Then $U = u\,p$, $V = v\,q$, and according to (10): $p = q$, so that according to the previous paragraph:

$$-\frac{\delta \phi}{\delta x} = \frac{R}{\varepsilon}\cdot\frac{u\,v}{u + v}\cdot\frac{\delta p}{\delta x}\cdot\frac{1}{p} + \frac{R}{\varepsilon^2}\cdot\frac{J}{(u + v)\,.\,p}$$

If there is no current the potential difference between two parts of the solution with the osmotic pressures p and p' is:

$$\phi' - \phi = \frac{R}{\varepsilon}\cdot\frac{u - v}{u + v}\cdot\log\frac{p}{p}$$

so that for $u > v$ (as in H Cl), the more concentrated part of the solution has a lower potential.

If we insert the value of $\delta \phi\, \delta x$ into the equations of movement (5) or (6) we obtain, removing J, the equation of diffusion:—

$$\frac{\delta p}{\delta t} = R\cdot\frac{2\,u\,v}{u + v}\cdot\frac{\delta^2 p}{\delta x^2} \qquad (13)$$

The diffusion of a single electrolyte ensues independently of any transmitted current which in general does not hold good for a plurality of electrolytes.

The density, ρ, of the free electricity at any point of the solution is given by the equation (7):—

$$\rho = -\frac{K\,.\,\Delta \phi}{4\,\pi\,c^2}$$

therefore here

$$\rho = \frac{K}{4\,\pi\,c^2}\cdot\frac{R}{\varepsilon}\left[\frac{u - v}{u + v}\frac{\delta}{\delta x}\left(\frac{1}{p}\frac{\delta p}{\delta x}\right) + \frac{J}{\varepsilon (u + v)}\cdot\frac{\delta \frac{1}{p}}{\delta x}\right]$$

In the absence of a current, therefore, if the fall of concentration is constant ($\delta p / \delta x + \text{const.}$), the density of the free electricity in the interior of the solution is opposite in sign to the difference $(u - v)$, and is therefore negative for H Cl.

It is, besides, proportional to the square of the decline in concentration and inversely proportional to the square of concentration. If we take, *e.g.*, a hydrochloric solution whose absolute concentration (number of grms. of molecules in the c.c.) varies uniformly by 0·001 along each 1 cm., then at the point where the concentration is 0·001 (1 grm. molecule to the litre) $(1/p)(\delta p/\delta x) = 1$. Hence at this point the electric density is:

$$\rho = \frac{K}{4\,\pi\,c^2}\cdot\frac{R}{\varepsilon}\cdot\frac{u - v}{u + v} = 1{\cdot}186\,.\,10^{-14},$$

wherein we employ the above mentioned of the constants K, c, R, ε, as well as the proportion $u : v = 272 : 54$. That is, the hydrochloric solution described contains at the point in question per c.c. about 10^{-14} electromagnetic units, or 10^{-13} coulombs of free negative electricity. That ρ on concentration becomes $0 = -\infty$ is connected with the potential becoming infinite.

If we further enquire into the migration of the matter, *i.e.*, the number of the positive and negative ions which in the time 1 pass through the transverse section 1 in the direction of the increase of x, the equation (2) gives us:

$$N = -\left\{\frac{\delta (U + V)}{\delta x} + \frac{\varepsilon}{R}(U - V)\frac{\delta \phi}{\delta x}\right\},$$

or if we take into account the values of U, V and $\delta \phi\, \delta x$ given at the beginning of this paragraph:

$$N = -\frac{4\,u\,v}{u + v}\frac{\delta p}{\delta x} + \frac{u - v}{u + v}\cdot\frac{J}{\varepsilon}.$$

Both the members on the right hand correspond to the influence of the ordinary diffusion and of the current passing through. Nernst has shown the agreement of the former with experiment, that of the second appears at once from the numbers of transportation of the ions.

As to the production of heat in any part of the solution situate between the points x and x', it appears from equation (11) of section 5, referred to the time 1 and the transverse section of 1, as follows:

$$W = R\,(N - N') + J\,(\phi - \phi')$$

wherein N, N′ and ϕ, ϕ' correspond to the values x and x' $> x$. By introducing the expressions which we have found for N and ϕ we have:

$$\left.\begin{aligned} W = R\,.\,\frac{4\,u\,v}{u + v}\left[\left(\frac{\delta p}{\delta x}\right)' - \left(\frac{\delta p}{\delta x}\right)\right] \\ + \frac{R}{\varepsilon}\cdot\frac{u - v}{u + v}\log\frac{p'}{p}\,.\,J + \frac{R}{\varepsilon^2 (u + v)}\cdot\int_x^{x'}\frac{d\,x}{p}\,.\,J^2. \end{aligned}\right\} 14$$

Thus the heat produced consists of three parts. The first is independent of the current, positive or negative, and represents the osmotic work. Its value depends on the increase or decrease of the totality of the ions. The second part is proportional to the intensity of the current, positive or negative, and springs from its predominance over the electric tensions existing in the solution. The third portion is positive and gives Joule's heat.

(*To be continued.*)

Electric Lighting at Eastbourne.—The Board of Trade has decided, in view of special circumstances to which their attention was recently drawn, to agree to a provisional order being granted to the Eastbourne Electric Light Company at the maximum rate of 10d. per unit, to which the assent of the Town Council had been duly given. The stipulation is made, however, that there shall be a revision of prices, if necessary, every seven years.

A SYNTHETIC STUDY OF DYNAMO MACHINES.

(*Continued from page* 487.)

VIII.—ARMATURE REACTIONS (*continued*).

As the magnetising force which urges the induction through the cross circuit is mostly expended in the air gap, it follows that in machines having a small gap the distortion is correspondingly great. If machines of different sizes are to work under similar conditions as regards tendency to sparking, the cross induction must bear to the forward induction the same ratio, or, in other words, the twist produced by the cross field on the forward field must be, in all cases, similar.

If we assume that, in the different sizes, there is the same induction per square centimetre in the armature, the forward field may be taken as proportional to the radial depth of the armature core or to the diameter, simply if the radial depth increases in proportion. The ampère-turns are also found in practice to increase as the diameter, so that both the forward field and the magnetising force on the cross circuit increase in the same ratio. From this it follows that machines having similar polar angles must also have their air gaps proportional to the diameter if they are to work under the same conditions as regards balance of fields.

Let us assume that we have in fig. 148 a machine in which the brushes have a lead of 20°, the ampère-turns exciting the cross field being, under these circumstances, $= \frac{280\,A_2}{360}$, where A_2 stands for the whole of the ampère-turns on the armature, *i.e.*, one half of the conductors counted all round the periphery, multiplied by one half of the total current. Due to the armature current the induction in the air gap will be disturbed, being reduced under the opposite polar corners, *a* and *b*, and increased under the corners at *c* and *d*. If the pole pieces are far from saturation, the forward induction will, under the influence of the cross field, as readily take the twisted path as the straight path, and, while the weakening and

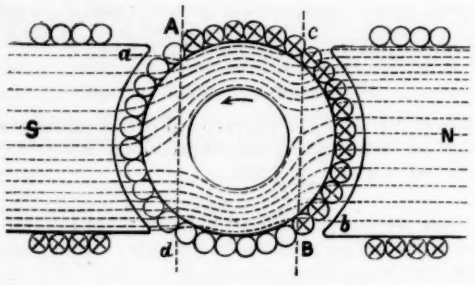


FIG. 148.

strengthening at the polar tips depend upon the induction produced by the cross ampère-turns, under these circumstances the induction will be strengthened at *c* and *d* to the same extent as it is weakened at *a* and *b*. At points cut by a line midway between the tips joining N and S, the induction has its normal value, being uninfluenced by the cross field.

We will assume that the brushes are close behind the pole tips, so that we have to consider the cross induction as going through the air gap which lies between the armature core and the polar faces only. It will be observed that no account has been taken of the length of the armature in the direction of the spindle, the reason being that since both the forward and cross fields are directly proportional to the length, this dimension need not enter into our considerations. The path of the cross circuit in the iron being short, and the pole pieces being far from saturation, we may assume, as stated in a previous article, that the whole of the magnetising force of the cross circuit is expended in forcing the lines to jump the air gap twice. That the cross induction must not be great enough to produce a reversal of the forward field under the brushes has already been pointed out, but that the forward field required to reverse the armature current is small has also been made apparent. Assume for the moment that the induction of the cross field just balances that due to the forward field, so that the induction under the brushes is nought—an unworkable condition, but still useful as showing the kind of law we obtain. Let l be the length of the air gap in centimetres, and I the induction in it. If we are to have the induction nought at the brushes, the cross induction must be equal to the forward induction = I. The magnetising force to produce this will be $2\,l \times \cdot 8$ I ampère-turns, so we have for this machine the relation :

$$\frac{280\,A_2}{360} = 2\,l \times \cdot 8\,I,$$

and

$$A_2 = 2\,l\,I.$$

This shows that the ampère-turns on the armature must be proportional to the length of the air-gap and to the normal forward induction in it. Assuming that the latter is the same in different sizes, since the ampère-turns increase with the diameter, we see that the air-gap must increase in the same ratio, provided the polar angles are similar. But if armatures were loaded as indicated by the above relation there would be no forward field to reverse the current in the commutated sections; nor, if the ampère-turns were reduced to allow of sufficient field, would the machine have any working margin. It is necessary to allow here, as in all practical work, a very considerable safety factor, and, accordingly, we find that as a general rule armatures are not loaded with much more than half the above number of ampère-turns. In practice, A_2 is roughly equal to the product of length of the air-gap and the induction. The angle embraced by the pole pieces varies from 120° to 140°, a common angle being 130°.

If the total flux through the gap remains unchanged it will be seen that as the angle is reduced a greater armature load can be carried. With a smaller angle the induction is increased; and, assuming that the brushes will occupy about the same position relatively to the polar tips, the turns producing the cross field are reduced, both these circumstances combining to make a greater armature load permissible. As already stated, it is assumed, in working out the above relation, that the brushes are close behind the polar tips.

Working out the relation between the diameter of the armature and the ampère-turns, carried for a number of the best known English and American machines, the equation, A_2 = diameter in centimetres, × 280, is found to give a very fair mean of the general practice in drum winding. For cylinder armatures the same rule holds good provided the induction in the gap is similar. In drums the central hole is generally about ·4 of the core diameter, while in cylinders it is ·6 or ·65. The latter have an induction of 18,000 or so, while in the former, if no special ventilating arrangement is provided, it is seldom more than from 10,000 to 12,000. This gives for the same pole angle about the same induction in the gap, and though in the case of the cylinders the inside wires have a disturbing influence, the greater induction in the cores of these to some extent throttles the cross field. If the induction in the core of the drum armature, and consequently in the gap, is increased, the load can be increased proportionally; but in this case some ventilating arrangement will be required to carry off the heat generated in magnetising so large a mass of iron.

(*To be continued.*)

Roumania.—Mr. Vice-Consul Churchward, of Kustendjie, states that in view of certain changes which are being made in that town, improvements which would afford remunerative investment for enterprising capital must follow. In these he includes water-works. gas or electric light supply, and public granaries.

THE ELECTRIC LIGHT IN PARIS.

FRENCH *versus* FOREIGN APPARATUS.

As our readers are already well aware through our columns, the Paris Municipal Council is bitterly hostile to the use of foreign, and especially English, electrical *matériel*, and on the presentation of the report of the Technical Electricity Sub-Committee to the Council, the following proceedings, which, if anything, were more violent than usual, took place :

M. LYON-ALEMAND : I bring you the conclusions of the sub-committee on the state of the electric centres of the concessionaries of the city of Paris. My report has been printed and distributed, and you have been able to see our conclusions are absolutely moderate. We grant three months at some points, and six months at others, for the strict application of the clauses of the specification. We wish to compel these companies not to get their machinery from abroad, and to give, *per contra*, work to French industry. The Council has not hesitated to ratify these conditions, and recently appointed a committee charged to see they are observed. This committee found that some of the companies fulfilled their obligations, and others did so more or less completely. The resolution asks the Administration to force the companies to conform to the specification. Here is, gentlemen, this resolution : 1. Portable and other steam engines of foreign origin employed in the electrical stations must be replaced by French engines within three months, dating from the day of the present resolution. 2. For compressed air engines the period will be a year, but the Administration is invited not to let any foreign fabrication start on the service. 3. Currents produced by Thomson-Houston dynamos shall not pass through the canalisations conceded for the private service. 4. The Administration is invited to draw up an exact plan and to see : 1. That no station other than the stations shown on the plan shall be in communication with the canalisations ; 2. That the canalisations destined for the public service (lighting of the boulevards) shall have no communication with those which are destined for private lighting. A Voice : Why ? M. Lyon-Alemand : It has appeared abnormal to the committee that stations destined for private lighting, and in which the machinery is not subjected to the conditions of the specification, could co-operate in public lighting. The Director of Works : That will bring about the making of one canalisation the more. M. Lyon-Alemand : The committee is of opinion that the works supplying private customers should not, I repeat, co-operate in public lighting, and that because it would be impossible for us to usefully control their working and their receipts, and to impose on them the conditions of your specification. Here are, gentlemen, the other articles of the project : 5. Communication with outer canalisations shall no longer be granted to any station before the committee has seen whether all the *matériel* is of French origin. 6. The Administration is invited to see that the clauses of the specification relative to the conditions of working are rigorously observed, as well in the municipal stations as in the concessionaries stations. I do not insist further, and I limit myself to answering the objections which may arise. M. Guichard : M. Lyon-Alemand had no need to call for objections. I thought he would do nothing but read his project. The first paragraph is thus couched : "Portable and other steam engines of foreign origin employed in the electrical stations must be replaced by French engines within three months, dating from the day of the present resolution." I have voted with the great majority of the Council the obligation for the concessionaries to buy their *matériel* in France. I am, therefore, a partisan of the principle. But I do not on that account lose the feeling of equity towards those with whom we have treated. Now the proposition for which I voted, and which I have just mentioned, had not the meaning given it by the first paragraph of the project. It had not the retroactive effect which it is a question of giving it to-day. The truth is that this resolution is simply aimed at one company, and I do not hesitate to constitute myself its defender, on account of the too energetic fashion in which it has been treated. The first specification imposed on that company—which contained no clause relative to the source of the *matériel*—was signed on February 7th, 1889. As soon as it was signed the company, pressed by the very short time allowed it to get to work, ordered its engines, and it was a month after that the Council voted the obligation for concessionaries to purchase their engines in France. In these circumstances, it is inadmissible that the companies should now be forced to change their engines. I understand that the members of the Electricity Sub-Committee, who do not form part of the Municipal Council, do not know the sense of our resolution. But it was not so with M. Lyon-Alemand. I therefore demand either the annulling of the first paragraph or the following addition to be made : "This clause shall have no retroactive effect." As to me, I should prefer the annullation. I reserve the right to present other objections on the other paragraphs. M. Lyon-Alemand : It is materially impossible not to give a retroactive effect to the first paragraph, in that the companies were only able to proceed to their installation after the authorisation of the Administration. Now this authorisation has only been given after long discussions and numerous interviews. A year before it was granted it was understood that the engines should be of French manufacture. It was only at the last moment that an exception was made for the canalisation and for the lamps. It was, therefore, with full knowledge that the companies have acted. All the companies, save one, conformed to the clause of authorisation, and only a furnace door which was not French was found among them. I do not see why one should escape from the general obligation. Observe, gentlemen, that it was not a question of a fixed boiler, of a costly installation ; it was only the question of a portable engine. The name itself indicates the small importance of the matter, and that it required but little sacrifice. With regard to the compressed air engines, we recognised that the question was more complicated ; and it was on that account we granted a year in which to effect the change. Whatever it be, it was only after a year's studies that our decision was arrived at ; studies which the companies knew perfectly well, and they cannot maintain they were taken by surprise. Thus we cannot, *a fortiori*, accept the employment of engines purchased previously to your decision. You cannot thus permit the violation of the specification which you issued. Of two things, one in short : Either the Council has imposed serious clauses and must make them respected, or else the clauses are impracticable—which I do not admit—and it will proclaim it to-day by changing its opinion. M. Maurice Binder : I do not come, gentlemen, to combat the conclusions of the committee. Like M. Lyon-Alemand, I was a member of the Electricity Sub-Committee, with him I have visited the works, and I recognised that the conclusions which he submits to-day were well-founded. These said, I would call the attention of the Prefect of Police to one particular point. I read in the report : "Relatively to the Thomson-Houston dynamos, despite the grave inconveniences and the real dangers which this system of distribution presents (there has already been a workman killed at the Eden theatre), it is certain that it offers, especially from a public lighting point of view, incontestable advantages." It is indispensable, in these circumstances, to know whether the Prefecture of Police has taken all the necessary steps to prevent accidents. Does it intend to allow dangerous currents to circulate ? and is it responsible for safety ? M. Lyon-Alemand : I have caused to be placed on the business paper a question to the Prefecture of Police as to the dangers of certain installations of electricity in the theatres. I ask that the discussion of Article 3 of my report be awaited in order to examine this question ; it will be more useful at that time. M. Binder : Certainly. But it is of importance that the Prefecture of Police should give us information as to the possible dangers of certain installations. M. Sauton :

As a member of the Electricity Sub-Committee, I must say that I do not find myself in accord with M. Lyon-Alemand on the subject of the source of the engines. M. Lyon-Aleinand tells us that the front alone of certain engines was of foreign origin. That is incorrect. The whole of these engines—and they are colossal—appear of foreign origin. It is clear that if the English company had put its name-plate on the front of these engines, it furnished the engines. The reporter had quoted the report of M. Michel Lévy, which said: "Four Babcock and Wilcox boilers have their front of metal come from abroad; the company affirms that two among them have been put together at M. Fontaine's, constructor, at Madeleine-lès-Lille, and two others at M. Mériaux's, at Blanzy-lès-Arras." Thus M. Lévy says that the company affirms—but he refrains from taking the responsibility for that affirmation. What has been demonstrated to us is that a portion of the machinery was not made in France—I mean the heating tubes. Up till recently there were no works in France fitted up for this manufacture. We must examine the spirit and letter of the contract, for there is a period of 18 years to elapse, and we must reserve the future. Let it be remarked that a change of the Edison boiler is not asked. It has maybe been put together in France, but that is all we know. It is necessary that we should be completely enlightened on this point, for it would be to give to French industry a singular protection to close the eyes to this foreign manufacture. That is why, in the last paragraph of the project, after the words "of foreign origin," I propose that there be added "that they may have been, or not, put together in France." It is necessary, in short, in my opinion, that the whole engine should be manufactured in France, and that we should not tolerate putting together alone. M. Lyon-Alemand: M. Sauton says that I quoted a passage from M. Lévy's report. Well, I have done so; I have also inserted the reports of MM. Potier, Michel Lévy, and Côte, not allowing myself any personal appreciation. And, since you have read a portion of the article from M. Lévy's report concerning the Babcock and Wilcox boilers, let us continue the reading of that article. The speaker repeated the above extract, and continued: The boilers alone have the front in metal which is of foreign origin. Note this: If you can prove that the remainder is also of foreign origin, I shall be ready to vote your proposition of the other engines of which we have just spoken. I read: "All the motor *matériel* employed by M. Victor Popp is of foreign origin; the compressed air, or mixed air and steam, come from the works of Davey, Paxman & Co., and have been constructed in England; six boilers of the portable type come from the same works; two other boilers, also portable, have been constructed by Ransomes, Sims and Jefferies." M. Binder: We have been ten in verifying that. M. Lyon-Alemand: The other companies have made efforts in order to have engines of French construction. The engineers have not been able to affirm whether their engines were or were not constructed in France. It has been inferred from the presence in these engines of certain tubes, of which the type does not exist in French construction. But if there is something we do not possess, or which is made better abroad, must we demand its suppression? It has been demonstrated that the engines purchased abroad were not superior to French engines. Why have they been taken from abroad? I have not to enter into that order of ideas. I limit myself to stating that there is there an infraction of the specification, and what we ask is in reality only a pure and simple recall to the execution of the contract stipulations. What does the article to which I allude say? "That portable and other steam engines of foreign origin employed in the electrical stations must be replaced by French engines within three months." If anyone wishes to add that these engines shall be put together or not in France, I make no objection. M. Guichard: The Council will permit me to insist on the suppression of the article. But if, despite the reasons which I have just set forth, the Council vote it, I demand that it shall have no retroactive effect. Article 27 of the specification was thus drawn up: "The *matériel*, that is to say, the electric wires and incandescent lamps, shall be supplied by French firms." What does this article apply to? What is its precise meaning? M. Maurice Binder: It means the whole *matériel*. M. Guichard: There are no two possible interpretations. It said so little of the whole *matériel*, that a few weeks later the Administration added an additional article in these words: "The whole entire *matériel*, including therein the wires and lamps." On February 7th, 1889, the concessionaires signed the specification conveying purely and simply that the wires and lamps should be of French origin. On March 22nd following, they signed an addition, in virtue of which all the *matériel* had to be French; that is, that the engines themselves should come from French works. For my part, I believe that we cannot, without unquestionable reasons, oblige the concessionaries to turn a completely new plant into old iron. It is of the most elementary equity not to give a precept any retroactive effect. The specification was lengthily discussed here. As soon as the agreements had been signed, the concessionaries hurried to order their engines, the more so as they knew that if they were not ready within the short time allowed them, the concession would be withdrawn. A month later, they were told that the engines must also be of French origin. The concessionaries immediately countermanded their orders, but the builders answered by a refusal. Such is the position, and I am surprised that the Third Commission, knowing it, should propose to the Council to give its resolution a retroactive effect. That would be to take away with one hand what had been given with the other. M. Lyon-Alemand: Gentlemen, I claim, as I have said already—and this observation is in no way aimed at my colleague, M. Guichard—that the objection which has been presented by our colleague has not been in good faith. The article as it has been printed was inscribed, through an error due to the writing of the *Comptes-rendus*, in the terms in which M. Guichard has just read it again. It was after the voting of the amendment of M. Faillet, regarding the wires and lamps, that there were entered the words: "That is to say, the wires and lamps." But, gentlemen, if the companies had relied, in applying the specification, on our discussion they would have had no argument. They knew very well to what they were engaging themselves. There was the less doubt on this point, as eight days after the Council's vote I told the Director of Works, who asked me how he should interpret this article, that it only turned upon an error of editing, and that it was well understood that everything, without exception, should be of French origin. The objection presented of the fact of this editorial error is therefore an objection in bad faith. M. Maurice Binder: M. Popp himself does not contest the article in question. M. Guichard: That is a gross error. M. Maurice Binder: I assure you that is not so. M. S. Paulard: Why have not those interested made a reservation as to this additional article at the time of signing. M. Guichard: They made them to those before whom they signed! ("Oh, oh!") M. Lyon-Alemand: The specification included an article, according to the terms of which all engines and *matériel* were to be of French origin, and that specification was signed by all the companies. It was in the course of the discussion that M. Faillet presented the additional proposition which we have voted, and which those interested have never ignored. It was an addition to the specification which they had signed, and it could not escape them. I beg the Council, therefore, to cause the rights of French industry and its resolution to be respected. It is scandalous that companies supplying the city of Paris should order their *matériel* abroad. M. Guichard: I ask that the decision which the Council seems disposed to take shall have no retroactive effect. It is not possible, in short, that in requiring the use of French *matériel*, we should condemn as old iron all that is already existing. I ask them that those who can show in an indisputable manner that their orders were given before

the signing of the contract shall not be dispossessed of their *matériel* or their concession. M. Paulard: The orders were not given till after the concessions were obtained. M. Binder: I ask you, gentlemen, to adopt the conclusions of the committee. Out of three concessionary companies, two are perfectly regular. Why does M. Guichard wish to make an exception in M. Popp's favour? Before going to visit the works, we wrote to the three concessionaries, asking them for information, and M. Popp himself answered that he was ready to conform to all the conditions of the specification. M. Rouselle, President of the Third Commission: I have received a petition from the Société d'Enterprise Générale de Distribution et Concession d'Eau et Gaz et de Travaux Publics, which complains that the proposed measure takes very much work, and deprives a crowd of workmen of their livelihood. M. Ferdinand Duval: It is a petition from M. Popp. M. Lyon-Alemand: It is from the contractor of the Popp company. M. Rouselle: It was my duty, in any case, to present it. M. Lyon-Alemand: It is absurd to pretend that the resolution we are about to pass deprives a single workman of his labour. The President: I put to the vote Article 1 of the committee: 1. The portable and other steam engines of foreign origin employed in electrical stations must be replaced by French engines within three months from the date of the present resolution. M. Sauton proposes to add to the words "engines of foreign origin," the following, "which may have been put together or not in France." M. Lyon-Alemand: I raise no objection to that; but I draw the Council's attention to the difficulty of knowing whether the engines have been put together or not in France. I can be nothing but favourable to M. Sauton's amendment, since I am a partisan of the complete installation of the engines in France. M. Sauton's amendment was adopted, and Article 1, as thus amended, was also adopted. M. Faillet: I have not voted, because I look upon the verification which M. Sauton claims as impossible. The President: There remains M. Guichard's additional article as follows:—"This resolution shall have no retroactive effect." This addition was voted upon and rejected. The President: I put Article 2 to the vote. It runs as follows:—"For compressed air engines the period will be a year, but the Administration is invited not to let any foreign fabrication start on the service." M. Sauton: I ask the Council's pardon for insisting, but the question is grave, and merits the retention of our attention. When this article was proposed to the committee, I asked whether it were possible to make compressed air engines in France. The committee answered in the negative. M. Lyon-Alemand: That is an error. M. Sauton: Not at all. I was told that the French industry was being fitted up for that purpose. M. S. Paulard: That is a year ago. M. Sauton: Therefore our industry instals its fittings; it does not construct yet, but it has passed contracts. Now, you know very well that an industry at its start can only produce by degrees; consequently, if you absorb its first productions to replace the engines at present in use, you will forcibly arrest the progress of electricity. Is it rational, when we have so many new stations to establish to commence by requiring the alteration at short notice of those in existence? I say at short notice, for I believe I have demonstrated to you that a year's notice, as indicated by the committee, is too short. I impose the replacement of foreign engines—nothing better; but leave to the concessionaries in the first place the means of establishing new stations before touching the old. Therefore, let the principle contained in Article 2 be admitted—it is very good; but I demand that the year's delay be suppressed.

(*To be continued.*)

Electric Lighting of Railway Stations.—We hear that the Lancashire and Yorkshire Railway Company has decided to light Tithebarn Station, Liverpool, by electricity, commencing from August next.

ON GRAPNELS.

OUR issue of May 2nd contained an illustrated notice of a new form of holding-grapnel patented by Capt. Henry Benest, and we now propose to review, so far as our acquaintance with the subject may permit, some of the types of grapnel which from time to time have been introduced.

It is certainly true that an appliance such as a grapnel can be of interest to but a comparatively limited number of readers, but if no other reason could be given for the introduction of such a subject than the fact of its being a change from the usual articles on electric lighting, this in itself is sufficient to justify the dedication of some space to the discussion of an apparatus which in its own particular sphere holds a position of some importance.

We naturally do not attempt to place the advantages to be gained by the general public from the introduction of a better form of grapnel in the same category as the benefits likely to accrue to us from the introduction of a more efficient dynamo, or the discovery of a more satisfactory method of distributing current for electric lighting purposes and the transmission of power, or of a system of simultaneous duplexing or multiplying telegraphic communications on the same wire. But every improvement has a comparative value.

We will premise that the conditions which should be present in a perfect grapnel are:—

Simplicity, strength, and accessibility of all the parts;

Absence of springs or of any similar delicate mechanism;

Ready removal and exchange of any damaged part;

Sufficient weight to ensure good dragging without being cumbrously heavy;

Suitability of shape and outline to admit of easy handling.

These conditions would appear to be very fairly fulfilled by the grapnel lately patented by Capt. Benest, and it certainly appears to comply with them to a greater extent than any other pattern which has come into notice.

In the issue of the *Electrician* for May 2nd there appears a leaderette on the subject of gripping and holding-grapnels. While in the main agreeing with our contemporary's remarks, we would observe that it is by no means unusual for a short loose end to come up without twisting round the other part of the cable or the grapnel. Most cable engineers will, we think, bear us out in the statement that many an end has been lost in this manner, for it must be remembered that to hook the cable near the broken end is frequently a matter of great importance, often, indeed, a question of absolute necessity.

Nor is it always an advantage that, when on the bight, the grapnel should "render" under the cable in a strong current, more particularly should the cable be held, as is frequently the case, on one side by a rocky bottom. Under these circumstances the current might occasion the rendering to take place in the direction of the held part, eventually bringing strain at a most undesirable place, and losing the advantages of such slack as might be available at a greater distance from the held portion.

"Rendering" is still more objectionable in the case of an old and weak cable; the outer serving is certain to be completely stripped off, and it would be good luck if many a broken wire were not caused.

To resume our remarks on grapnels in general. In rough work, such as is not unusually encountered in cable operations, simplicity in the various parts of all and any gear, is a point of utmost importance; that everything should be as strong as possible without running into the extreme of excessive weight, goes without saying; and it is a matter of not inferior consequence that the various parts should not only be removable but also very readily accessible. The design of a grapnel having removal prongs or toes was

a step in the right direction, but the idea of combining a cutting and holding apparatus in the same grapnel is, we would submit, with all due deference to experts, a wrong move. The space required to afford a sufficiently large holding surface is, in these combination types, encroached upon by the cutting apparatus to a dangerous degree, for unless the holding surface has area enough to prevent nipping, actual experience has shown that in the types referred to, an apparatus has been invented which cuts on two sides instead of on one only.

Another objection is, that with a cutting and holding grapnel the dragging can only be done in one direction, as the cutter is a fixture, and it is a matter of importance that regard should be paid as to which side the cable is to be cut on. The disadvantage of being compelled to pick up the grapnel and steam back to the original position each time the drag has to be repeated, is apparent.

As an illustration of how difficult it is to successfully combine the cutting and gripping principles, one has only to carefully watch the action of the scissors designed for cutting and holding grapes; this appliance may be found to work well once in a lifetime.

A very curious fault with many forms of grapnel is their unwieldiness, not alone through excessive weight, but also in a great measure owing to their clumsy construction. When the needlessly severe work the handling of such grapnels entails upon the men is considered, it will be recognised that our strictures in this respect are fully justified.

Several designs contain almost as much mechanism as a watch, and not only are such easily damaged pieces as springs employed, but in many cases the locking arrangements, none too simple in their construction, are imperfectly protected against possible derangement from the ingress of stone, gravel or broken rock.

Numerous attempts have been made to design a grapnel whose prongs should be protected against catching in rocky ground. The first of this type was introduced by Captain Blacklock, who put a web of plate iron on the grapnel shank, leading from the head of the shank to the tip of each prong. No form, however, seems to satisfactorily effect the purpose intended, for if the guards are placed so as to save the prongs from catching in rocks, they will also prevent the cable from being caught. If this objection were not sufficient, there is still the fact that if these guards or fenders were made stout enough to withstand the constant knocking about over rocky ground, the grapnel would then become far too heavy.

A very excellent idea is that of pivotting the toes or prongs of the grapnel so that on the points catching in rocky ground the prongs will yield instead of, as is generally the case with perfectly rigid fixed prongs, breaking. This type of grapnel has been proved in actual work to attain its purpose, and there is no doubt but that a great deal of time, otherwise wasted in heaving up, changing, and re-lowering the grapnel, may be saved by the employment of the self-relieving form. The fact that springs are used is, however, an element of weakness, for it happens that these springs often rust up and the prongs become set.

We are insufficiently acquainted with the result of the employment of those "electrical" grapnels which give warning when the cable is hooked, by means of a contact in the forks of the prongs and through a conductor carried in the centre of the grappling rope. We should imagine, however, that a piece of rock or very stiff clay well home in the prongs would give the same warning as if the cable had been hooked; and the fact that the grappling rope is all in one length instead of, as is usually the case, made in 200 fathom lengths, would be detrimental to its general adoption, the inconvenience of not being able to speedily disconnect a damaged portion of rope, or a length not required, being very great.

We append a list of most, we believe, of the grapnels which for submarine cable work have from time to time been brought before the public.

Year.	Official Patent Number.	Name of Patentee.	Remarks.
1860	...	Blacklock	Protected prongs
1873*	4,100	Lambert	Cutting and holding
1874	4,253	Johnson	Cutting
1874	4,369	Lambert	Improved cutting and holding
1876	4,167	Jamieson and King	Self-relieving prongs
1882	2,311	Johnson and Anderson	Electrical
1882	3,143	Trott and Kingsford	Electrical
1885†	5,808	Mance	Protected prongs
1885	11,064	Johnson and Phillips	Cutting and holding
1886	16,917	Jamieson	Improved self-relieving prongs
1887	7,611	Johnson and Phillips	Electrical
1888	11,913	Lucas	
1889	15,138	Stafford	
1889	19,152	Benest	Holding

* We believe that in 1867 or 1868 Latimer Clark designed the first cutting and holding-grapnel.

† Many years ago a similar form of protected prongs was introduced on board the old cable steamer *Monarch*, and since then several suggestions have been made for the employment of a similar type, and although no patents were taken out, drawings and models were made.

DISCOURSE ON STORING UP THE ALTERNATING CURRENT.

Delivered by Dr. A. FŒPPL, of Leipzig, before the Berlin Electrotechnical Association, April 22nd, 1890.

[COMMUNICATED BY THE AUTHOR.]

OF late it has been frequently asserted that the alternating current cannot be stored up. As far as the present technical position is concerned, this assertion cannot be objected to, but it is devoid of all foundation if it is meant to refer to a future technical development.

This appears very plainly from the fact that the energy contained in the alternating current may be converted into mechanical energy by being conducted into a motor. But mechanical work can be readily converted into any form of potential energy by known methods, and can thus be stored up. In the present technical position, however, only the storage of the energy in a secondary battery can come into question. For storing the energy of the alternating current, we should therefore have to construct an apparatus combining an alternating current motor and a continuous current generator, and which consequently should be similar to the well-known continuous current transformers.

If the alternating current armature of this apparatus is supplied with current from the exterior circuit, it runs as a motor, and the current produced in the continuous current armature is stored in a battery. But as soon as the electromotive force in the exterior circuit decreases or ceases, the battery discharges itself back into the continuous current armature, which now serves as a motor, and an alternating current is produced in the alternating current armature which flows off in the exterior circuit. The chemical energy of the storage battery, which originally arose from the energy of the alternating current, is now converted back into the alternating current energy, and the entire process (disregarding unavoidable losses) is inverted. I believe, therefore, that by this process we have the same right to speak of storing up the alternating current as the continuous current.

The manifold transformation, of course, involves considerable losses of energy. It may, therefore, be called an improvement, if we succeed in charging a storage battery directly by an alternating current. I have

worked out a procedure which leads to this result, which I now beg to submit to you in its main features.

By way of explanation, I append the curve of tension at the clamps of the alternating current. By tension at the clamps I understand the potential difference of those parts of the alternating current circuit from which the current is to be taken to feed the battery. As a preliminary approximation, this curve (fig. 1) may be regarded as a sine line. For every branch of the exterior circuit in which no electromotive force occurs (*e.g.*, by induction), it may at the same time (if the proportions are suitably selected) be regarded as the current curve of the alternating current.

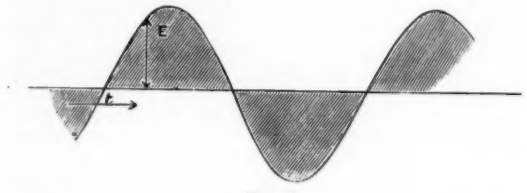


FIG. 1.

In order to employ the alternating current characterised by the curve, fig. 1, for charging a storage battery, there is required, in the first place, a change in its introduction after every semi-vibration of the current. An arrangement of this kind was indicated by Patten, and, as it appears from the last number of the *Lumiere Electrique*, had been previously proposed by Gaulard. Patten's arrangement has been described during the last few months in the principal technical journals. Hence it will be sufficient if I mention that the original alternating current is divided into two branches by the introduction of a commutator. One branch conveys the negative and the other the positive ways, as is shown in fig. 2. Hence a pulsating continuous current flows in each branch.

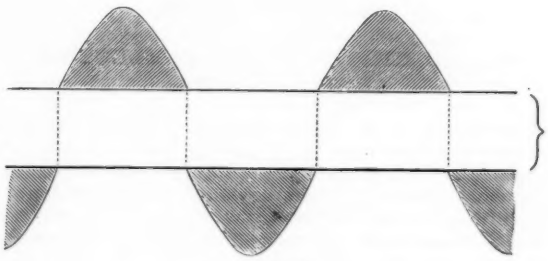


FIG. 2.

Such a current cannot, however, by any means, as Patten states, be used directly for charging a storage battery. The alteration of the insertion does, indeed, prevent the clamp-tension of the main lead from altering its sign during the connection. But it makes no difference in the periodic variation of the clamp tension. On the contrary, the counter-electromotive force of the battery retains its value unaltered. As long as the clamp-tension is greater than this counter-force, the battery may be charged. But at the beginning and towards the end of the connection a discharging takes place. Under such circumstances, it does not appear how a permanent charge of the battery is to be effected.

When I first began to occupy myself with this problem I had no knowledge of Patten's researches. From the reasons laid down I rejected at once a simple alteration of insertion, and instead I sought to effect the connection of the battery to the alternating current lead in such a manner that the counter-electromotive force of the battery should follow approximately the same law of variation within each current-period as the clamp-tension.

To elucidate this, I represent the length of the battery by A, B (fig. 3), *i.e.*, A, B, must be proportional to the number of cells of the battery arranged in series. If we suppose that each cell is charged to the same tension, A, B may then at the same time be regarded as a graphic representation of the electromotive force of the battery. In A, B let there be taken two points, C and D, which may about correspond to two con-

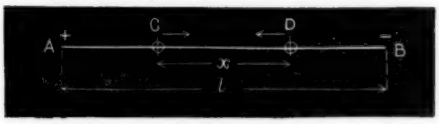


FIG. 3.

necting clamps of the cells of the battery. If A signifies the positive pole of the battery the potential difference of the points, C and D, is likewise positive; and, according to what has been said above, proportional to the extent, X, between both points in fig. 3. But if we set both points in motion in the direction of the arrows in the figure the distance, X, and consequently the potential difference of the points will first become smaller, then null, and lastly, negative.

Let it now be supposed that the points, C and D, execute pendulum vibrations between the ends of the battery, A and B, with a difference of phase equal to half the time of vibration. The law of variation of the distance, X, and hence of the potential difference of both points agrees in every respect with the law of variation of the clamp-tension of an alternating current conduction, as shown in fig. 1.

The vibrating points, C and D, may therefore be used as the points of attachment for the direct connection of the alternating current lead to the battery. For this purpose the condition is essential that those vibrations must be synchronous with the period of the alternating current, or better with the period of the clamp-tension of the alternating current. It is seen that, according to the production of the required attachment, the alternating current will be directly converted into chemical energy in the storage battery in the same manner as in a continuous current installation. It likewise needs no demonstration that the process is reversible exactly as in a continuous current installation. On the supposition that the connection of the points, C and D, is maintained unaltered, there flows an alternating current from the battery to the main lead as soon as the clamp-tension of the point of ramification falls.

In one respect only is there a noteworthy difference between this case and that of a continuous current battery; whilst the latter is always traversed in its entire length by a current of equal strength, the current here, in any moment, passes only through the portion of the battery situate between C and D, whilst the parts of the battery situate beyond this length are free from a current. The middle of the battery is of course, almost uninterruptedly traversed, but by a current of varying intensity. We may say that the current passing through the battery, even if it is kept in the same direction, still shows the properties of an alternating current.

This fact must be kept in view in the construction of the battery. The cells lying in the middle take more ampère-hours than those towards the ends. To prevent an unequal consumption, they must have a greater capacity than the latter. This demand may be met in every practically occurring case by the use of cells of different sizes, or by parallel arrangement.

For the better explanation of these relations, I venture to propose for any battery so constructed the name "alternating current battery."

I have endeavoured in the previous exposition to state the idea which lies at the foundation of my procedure as clear and definite as possibly, and detached from all details of construction. I hope thus to secure the advantage that no objections can be urged against the essence of the matter, for, so far as I can see, the process is quite free from objections.

Against the constructive execution of the idea, to

which I now proceed, objections of various kinds are, of course, possible. There is, however, scarcely a new procedure which does not encounter practical differences in its execution. I believe that I can show that these difficulties, in the present case, cannot by any means be considered as exceptionally serious.

(*To be concluded.*)

THE APPARATUS FOR ELECTRICAL EXECUTION.*

So much has been said concerning, and so many unauthorised and inexact descriptions have been published of the apparatus prepared for the first electrical execution, that a simple statement of the facts may be of interest to readers.

Of three equipments for killing by electricity procured by the State, the first to be employed is, as is well known, that at the Auburn prison; and to that particular case our description applies. The apparatus we may classify under three heads; first, the source of electricity; second, the means for applying the electric current to the unfortunate prisoner; and third, the accessories that have been deemed desirable.

The dynamo at Auburn prison presents no startling or remarkable features—it is not a "whirling implement of death," but an ordinary alternating current dynamo, such as is generally used for incandescent lighting. Previous to its being purchased for its present unpleasant task, it was in use in Oneonta, N.Y. It is a Westinghouse machine of the pattern manufactured several years ago, and was designed to supply 650 incandescent lights. Like other machines of its class, its field magnets are excited by a small direct current dynamo, driven by a separate belt. The electromotive force of the large machine can be regulated nicely by varying the current supplied from this exciter. When both machines are driven at normal speed and the field magnets of the alternator are fully charged, the electromotive force across its terminals is considerably in excess of 1,000 volts. As arranged at Auburn prison, however, the alternator is driven at about 1,450 turns per minute, and the exciter at 2,100. Under these conditions the electromotive force of the alternator is reduced to 1,050 volts approximately. It should be remembered that this figure is the mean electromotive force, and that, as in all alternating current dynamos, the maximum voltage is considerably higher. If the varying voltage followed the theoretical curve exactly—a sine curve—the maximum would be 12 times the average voltage, which latter is alone referred to in estimating the commercial voltage of a machine. In the case of the dynamo under consideration the electromotive force fluctuates more sharply, however, and the maximum voltage is probably nearly, or quite 2,000.

The current generated by this dynamo is taken to the execution room, and by pressing a simple button is connected to the electrodes. These are very simple in design. A rather flat cup of rubber, soft enough to admit of its edges yielding, and a little over 4 inches in diameter, contains the electrode proper. This consists of a thin circular brass plate, in diameter somewhat less than the cup. Upon this is fastened a layer of elephant's ear sponge to form the actual contact. A rod passing through the bottom of the cup carries the plate. A spiral spring inserted between plate and bottom of cup insures a firm contact when the cup is placed in position. The original plan was to apply the current to the head and feet of the condemned man, but that has been abandoned, and while one of the electrodes above described presses on the top of the head, the other is applied to the spine in the lumbar region, so that the brain and spinal cord are almost directly in circuit. The sponges on the electrode plates are of course wet, and holes in the rubber cups enable them to be filled with water if desirable.

As to accessories, the voltage produced by the machine is measured both in the execution room and dynamo room by Cardew voltmeters placed each in series with a special resistance box. As the instruments are ordinarily constructed they do not measure potentials as high as 1,000 volts; thus extra resistance became necessary. As an additional precaution against doubtful voltage, and to serve as an indication that the apparatus is working in its normal way, a bank of 24 incandescent lamps is placed in parallel with the victim. These lamps can be successively thrown in series with each other by screwing them in their sockets with a turn or two. This arrangement gives an accurate idea of the total voltage across the mains, since the lamps require a known voltage, and instantly show any decrease by burning faintly. In case the voltmeters fail, as sometimes happens, these lamps are an excellent guide for adjusting the machine. An ammeter in circuit enables one to make a close estimate of the current actually used. Aside from the measuring instruments there is a pair of large switches insulated with extraordinary and needless care, one throwing the lamps into circuit, the other closing the circuit in the mains which lead to the electrodes.

Of the deadly nature of the combination there is not the slightest doubt, but it must be remembered that although the machine employed is similar to those in use for electric lighting, for electrical execution the primary high potential current is used, while for domestic lighting the high potential wire is studiously kept out of houses, and the current actually passing through the lamps is from the secondary of a transformer and has a potential of but 50 volts, an amount which there is every reason to believe is entirely harmless. Even the primary current is practically no more dangerous than that used in ordinary arc lighting. Either will kill if given a fair chance, but both can easily be kept from becoming dangerous to the public.

* *Electrical World.*

THE ADMINISTRATION OF ELECTRIC LIGHTING ACTS.

WHETHER the good work performed by the representatives of the the Board of Trade in the past may be lessened by the blunders of the future is, at the present moment, shrouded in the mystical bonds of doubt. Many departmental offices have commenced with as good a prospect of accomplishing sound work which have become offices of circumlocution. The Board of Trade, as is well known, has the power of exercising very important functions in regard to electric lighting. It may at its own option refuse any order for which application is made, and already it has shown a leaning towards the public authority; a proceeding which is commendable in the interest of the ratepayers.

None the less important will be the powers exercised when electric lighting is fairly afoot. It may, as the Act says, inspect and inquire into the manner in which the undertakers are discharging their duties, which may prove a necessary precaution; it also has the power of dispensing with the approval of the local body if there is sufficient reason to show that the objection is frivolous; it may determine the period of each provisional order, in fact it undertakes to look after the electric light in a quite sponsorial sense. Considering, then, its extensive powers, the electric light in the various parishes of the United Kingdom may be said to depend entirely upon the officials of the Board of Trade, and it remains to be seen whether they will acquit themselves well of the task. We cannot pass a fair judgment on the small amount of work completed up to the present time, as it will in no wise be a criterion for their future performance. Last week, the members of the leading electric companies had an interview with Sir Michael Hicks Beach, as President of the Board of Trade, with reference to the

amending of clause 60, which, if persisted in, will certainly have the effect of seriously damaging the interests of the community generally. Under it, a local authority may keep an order unworked and, at the same time, will keep away any company which would, if the opportunity were present, light the district in a satisfactory manner. Already we have a case in point, where such a body nursed an order for 7 years, a condition of things which is not likely to happen in the future. However, in spite of a masterly representation of the case by Mr. Moulton, the deputation cannot be said to have gained their desire. They extracted a promise, which may or may not be fulfilled. We are rather afraid that the President lays too much stress on the words, "I do not look upon local authorities in the same light as private companies." Certainly local authorities should, as the representatives of the people, have advantages over a profit sharing concern, but it is a well-known fact that many local boards have members who are largely interested in the local gas works, a fact which must prove hurtful to the introduction of the electric light. Another weighty fact is that, as a rule, such representatives have no knowledge whatever of the science, and if a little is possessed, it renders the owner only capable of getting into the way of others and making himself obnoxious with his little knowledge. Still, if a local body takes up the order in an earnest spirit and is willing to pay for proper assistance, it may prove a blessing to its people. At any rate, if a body does not take up the order, it should not be from the non-assistance of the Board of Trade. Under the Acts of 1882 and 1888, the position of a supply company is not one for great envy; it will certainly be compelled to work hard for whatever glory and emoluments are to be gained. The Board of Trade has wrapped round each company rules which will require great care not to contravene. They are restricted in the use of certain streets, plans of any intended alterations of works must be submitted to the Board of Trade for approval, &c., and should any mistake, wilful or otherwise, be made, severe penalties will be inflicted which may possibly lead to the revocation of an order. In the case of a company being awarded powers, one is not easily convinced that it has secured a good thing, seeing that a given time must elapse before the public will consume the light in sufficient quantities to repay a company for its exertions. There is another direction in which companies may suffer, and which we think should meet with deprecation at the hands of the Board of Trade. A local body obtaining a provisional order for 42 years will most probably wish to sub-let it to a company for 21 years, or even less, for a given sum, thereby saving itself the trouble and putting money into its pocket through the transaction. Such a course cannot be too strongly condemned from whatever point of view one may look at it. In conclusion, we trust the Board of Trade may always have at its head a clever administrator of the Electric Lighting Acts, who will solve all matters of difficulty and doubt and so place electric light on a clear footing in the future.

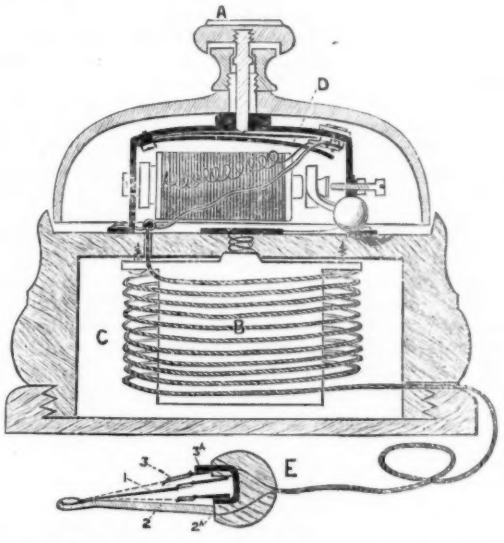
PATENT PORTABLE COMBINATION BELL.

A USEFUL and compact article has been brought out by Messrs. E. J. Tumber and Co., which combines a table call bell, invalid's bell set, burglar alarm and fire alarm. The whole apparatus, complete with battery, cord, &c., as shown in our illustration, only occupies a space of 4½ inches.

When used as a table bell it is only necessary to press the ivory tablet to call attention.

On unscrewing the bottom of the case the silk wire conductor and contact press will be seen. The latter enables the apparatus to be used either as an ordinary invalid's bell set, or by drawing back a sliding tongue on the spring arm it is converted into a burglar and thief alarm, and if placed between window sashes, in the crevice of doors, box lids, cabinets, &c., falls out on these being opened, and the spring being released continues to ring the bell until reset.

The fire alarm which is placed under the dome may be set to start the bell at any required degree of temperature; it is ordinarily set at 200° F.



A, Press for use as table bell; B, Battery; C, Space for flexible cord and contact press; D, Thermostat or fire alarm; E, Double contact press with sliding tongue on spring arm; 1, Position when not in use; 2, Making contact by pressure at 2A for use as an ordinary press; 3, Sliding tongue pushed back, allowing spring arm to fly up and make contact at 3A, for use as thief detector.

One of the pole pieces of the electro-magnet in the bell is slotted to receive a projection on the armature, thus enabling the bell to ring with small battery power. The battery contains no fluid and can be easily removed for recharging or renewing.

Considering the portability and many uses of this article, which we have examined for ourselves, it will doubtless be appreciated in some quarters.

THE ROYAL MILITARY EXHIBITION.

AS we have already announced, this exhibition was opened on Wednesday, last week, by H.R.H. the Prince of Wales, accompanied by the Princess and other members of the Royal family, in the grounds of the Royal Hospital, Chelsea. The contract for the electric lighting of the exhibition buildings and grounds was given to Messrs. Davey, Paxman and Co. This is the first time in England that a firm of mechanical engineers has obtained an order for the whole of the electric lighting of any exhibition or similar show, but Messrs. Davey, Paxman & Co. have been content with supplying only the steam engines and boilers, and have sub-let the furnishing of the electrical plant to the Laing, Wharton & Down Construction Syndicate, who have carried out the whole of the arrangements, with the exception of the installing of the engines and boilers.

The generating house is a corrugated iron structure situated on the south side of the grounds and is rather small for the machinery installed. The plant comprises two Davey-Paxman compound undertype engines and boilers, each of 40 N.H.P., four Thomson-Houston arc light dynamos, and two alternating current machines on the same system. The two engines drive a line of counter-shafting, having six pulleys, from which the dynamos are operated by belting. Each of the arc light dynamos runs at 850 revolutions, and will

supply current to 35 10-ampère lamps. One of the machines is retained as reserve, and the lamps from each dynamo are run in series. The alternators are driven at 835 revolutions a minute, the output of each being 35,000 watts at 1,000 volts, or say, 1,000 volts and 35 ampères. There are five arc light circuits operated from a common switchboard having suitable lightning arresters, and three alternating current circuits. The latter are regulated from a switchboard fitted with volt and ammeters, lightning arresters, double-pole double-brake-switch, and station transformer.

The whole of the okonite underground cables laid in the grounds are placed in the Archer electrical conduit which consists of a strong earthenware pipe. The joints are made on the principle of a tongue and groove. Liquid cement is poured into the sides of the grooves and this grips the tongue on all sides, thus forming a watertight conduit. The lamp standards, which are carried to a depth of 6 feet 6 inches in the soil, are 32 feet from the ground level. The base of the standards is of cast iron and the upper portion of wrought iron, the lamps being suspended from brackets. The cables from the generating house to the exhibition buildings are carried overhead and transformers for converting the current are placed at suitable spots. The total number of arc lamps distributed throughout the buildings and grounds is 100, and incandescent lamps varying from 8 to 200 C.P., but equal to 1,000 16-C.P. lamps are installed in the various offices, restaurants, &c. The exhibition is practically complete and, from its novelty and general arrangement, will doubtless be a success.

RAILWAY RATES ENQUIRY.

CLASSIFICATION OF ELECTRIC CABLES.

AT the Board of Trade Railway Rates Enquiry on Friday last, before Lord Balfour of Burleigh and Mr. Courtenay Boyle, held at the Surveyors' Institute, Great George Street, Westminster, the PRESIDENT stated that they had had an application from the Postmaster-General with reference to the classification of some articles.

Mr. STUART said that the first matter on which he desired to speak was as to telegraph posts, which were supposed to be in a special class.

Lord BALFOUR of BURLEIGH: What are the other articles?

Mr. STUART: Insulated copper wire, bare copper wire, copper wire, and copper insulated with gutta-percha.

Lord BALFOUR of BURLEIGH: You are aware—or, if not, we will tell you—that the written objections, with the reasons for them, should have been sent in to us in order to take these articles one by one in the different classes when they arise. We have passed them all now, and it will be extremely inconvenient to go back to this list, especially when we have not had your written reasons for objecting, and the replies of the railway companies thereupon. We think that the best course for the Postmaster-General to pursue is to send us written objections as to the position of those articles as they are proposed by the railway companies, stating where the Post Office wish them to be classed, and the reasons for it. We shall then send your communication to the railway companies for reply, and we will fix a subsequent day for going into the matter in the same way as we are taking the other articles, class by class.

Mr. STUART: Thank you, my lord.

Mr. COURTENAY BOYLE: You had better be present for some time to learn the kind of arguments that are used for and against the articles as to the classes. The letter of the Postmaster-General gives no reason whatever for objecting, except the bare intimation that you want low rates for these articles.

Mr. TROTTER, later on, said that with regard to dynamos and electrical machinery, and also "telegraph" batteries, he was satisfied as to the arrangement made.

Mr. TROTTER: I appear, my Lord, to uphold the objection No. 460 on the electric cables. The phraseology of the railway companies reply is literally identical with that of telegraph cables, No. 475, which the railway companies say is included in the term electric cables. There appears to be a remarkable impression about the way in which the cables are sent. I need not describe them to you, although they are a comparatively new article of manufacture rapidly increasing, and of decreasing value. I made careful enquiries of almost the whole of the electrical trades, and the very suggestion "that frequently the cable has to be coiled on to the waggons and uncoiled for delivery," has never been heard of, and has caused considerable amusement. The makers have never heard of such an instance, and I have challenged the railway companies to give me a single case where a cable has been sent in this manner. As to the same objection being applied to telegraph cable, I have applied to a gentleman (who is undeniably the highest authority), Mr. Preece, of the Post Office, and to other engineers in Her Majesty's Post Office, and I find that in course of Mr. Preece's 38 years experience, there are only three cases that he can remember in which a submarine cable has been loosely coiled on to the trucks in cases of extreme urgency, where they have been compelled to do it, and he has had experience of 118 submarine cables for telegraph purposes. Submarine cables are sent naturally by ship, and they are loaded on board cable ships, and are very rarely sent by rail. The usual way of packing ——

Lord BALFOUR of BURLEIGH: How are they carried on the railway?

Mr. TROTTER: In these three instances I believe the Post Office would tell you they were loaded most carefully by the Post Office officials on trucks and taken off again by them, in the only three cases I can hear of in "long lengths" and "shore ends," a heavy armoured cable.

Lord BALFOUR of BURLEIGH: In these cases they were specially loaded.

Mr. TROTTER: Yes.

Lord BALFOUR of BURLEIGH: How were they loaded?

Mr. TROTTER: I cannot give details. In those three cases they were coiled up as the railway companies state. That is the nature of our objection. The usual way is to put them in canvas coils, but generally a large consignment of cables is put on large wooden drums; those drums are logged, or boarded over, and it is absolutely impossible that damage can occur to them. Some are 10 feet in diameter. There was a cable laid down in Victoria Street in that manner.

Lord BALFOUR of BURLEIGH: How much loading is there in a truck?

Mr. TROTTER: Any amount up to the maximum weight. The weight of cables is increasing now in consequence of the increased use of lead, copper, and iron cables. If I might put in these advertisements your lordship would see the amount of iron and lead used in many cases, and that decreases the value per ton.

Lord BALFOUR of BURLEIGH: What is the value?

Mr. TROTTER: They are £32 to £48 per ton for lead covered cables, and up to £70 to £110 per ton for the ordinary electric cables, which consist of copper and insulating material only. Those are the average values which I have got from several makers. The value is decreasing per ton on account of the increased use of lead and iron, and also because there are various substitutes which are now being introduced which are cheaper than India-rubber.

Lord BALFOUR of BURLEIGH: Is there a tendency to make these articles more valuable and more intricate than they used to be?

Mr. TROTTER: I think not, for this reason, that larger cables are being used now, and the mere fact that cheaper things than India-rubber are being employed for insulation and lead and iron coverings, make the value per ton considerably lower than it was a few years ago.

Mr. COURTNAY BOYLE: Now, surely the term "electric cables" covers articles of both different description and bulk; it would cover the main line of an electric lighting company which might not be thicker than a thumb; and it might cover the concentric copper cable of the London Lighting Company, which is as thick as a man's leg.

Mr. TROTTER: That copper cable of the London Electric Lighting Company is made in lengths, and it would be rather a conductor than a cable. It is a special article. But I can assure you the values of different sizes of cables up to a half-inch section of copper.

Mr. COURTENAY BOYLE: Half-inch section. How would that be carried; would it be carried in coils?

Mr. TROTTER: Yes; coiled upon a wooden drum. It would look like a large flat cheese-shaped cask.

Mr. COURTNAY BOYLE: Would not the term "electric cables" cover an ordinary service wire of an electric lighting company?

Mr. TROTTER: Certainly.

Mr. COURTNEY BOYLE: And that would not be coiled over a drum?

Mr. TROTTER: Very generally it is coiled on drums. Otherwise it is sent in canvas-covered bundles. But that is only on a small scale. I saw last night in High Street, Kensington, such drums standing in the street. The conductors are covered. The small sized cables are worth £75 per ton.

Lord BALFOUR of BURLEIGH: What have you to say?

Mr. WILKINSON: We have not much to say in answer. The term cable, as used by us, applies to other than electric cables. Our answer applied to cables generally, not specifically to electric cables. Our present powers are the highest powers in the present classification, and we ask you to include them fourth in the schedule. I think it is reasonable, having regard to value, bulk and risk.

Mr. TROTTER: The definition is electric cables, and they prefer to include telegraph cables. I am not aware of any other cables. I passed it over when cables came up. The word "cable" does not appear in this schedule of Class 3, so I waited till electric cables came on. But I am not aware that they are used for any other purposes than for the conveyance of current for electric lighting purposes, and for the transmission of powers, or telegraphic purposes.

NOTES.

Electric Lighting at Exeter.—As the result of the efforts of the borough officials, the provisional order for lighting Exeter by electricity has been altered so as to give a compulsory radius of half-a-mile and an optional radius of one mile. A number of important public buildings are included in the permissive radius, and the Mayor stated at the last meeting of the council that this concession would make electric lighting possible in the Borough, whereas otherwise it would have been impossible.

Electric Light at Croydon.—At the last meeting of the Croydon Town Council, a resolution was passed requesting the General Purposes Committee to report whether, under existing circumstances, they could recommend the council to seek electric lighting powers in the next session, and if so, what steps should be adopted.

Electric Light at the "Bolton Evening News" Office.—We are informed that Messrs. Ernest Scott & Co., of Newcastle-on-Tyne, have secured the contract for lighting the new offices and printing works of the *Bolton Evening News*. The installation will consist of two 150-light "Tyne" compound-wound dynamos fitted with heavy flywheels to be driven from two 20-H.P. "Otto" gas engines which also drive the rest of the machinery. The installation will ultimately consist of 400 16-C.P. incandescent lamps and the main and branch cables are to be put in for this number in the first instance, but 280 lamps only will be installed at the present time, the remainder of the lights to be added as required when further dynamo power will be provided also. Messrs. Bradshaw & Gass, of Bolton, are the architects and the work is being carried out under their supervision.

Electric Lighting of Heilbronn.—The Board of Directors of the Wurtemberg Portland Cement Works, at Lauffen, have finally decided to utilise 300 H.P. out of the superfluous 1,000 H.P. available from the River Neckar for the electric transmission of power and electric lighting of the town of Heilbronn, 11 kilometres away from the power source. The necessary concessions have been applied for and there is a prospect of the installation being in working order before the coming winter. The design and execution of the scheme has been entrusted to Mr. Oscar von Miller, of Munich, late director of the General Electric Company, of Berlin.

New York Lighting.—The New York Gas Commission, at its meeting, April 18th, awarded contracts to the gas companies, and rejected all bids from the electric lighting companies on the ground that they were excessive. The Mayor, who is one of the commissioners, said it was evident the electric light companies were in combination.

Electric Light at Taunton.—A local contemporary says many enquiries have been made respecting the time when the Taunton Electric Lighting Company will be able to undertake domestic lighting. Many householders have expressed a wish to be supplied, if the terms are not extravagantly in excess of the average cost of gas; but little or nothing has been heard of the matter lately. The explanation is that the Board of Trade authorities have not yet completed their test of the new conducting wires, and until they do so these wires cannot be used. It is expected that the required authorisation will be forthcoming in the course of a few days, when the company will be prepared to give estimates for lighting any house, factory, or workshop in the borough.

The Maxim-Weston Company.—Readers are referred, in our City columns, to the speech of Mr. Marks, which is probably unique in the transactions of electrical companies.

Electric Lighting in the Parish of St. George's, Hanover Square.—In answer to Mr. Leveson-Gower on Monday, Sir M. Hicks-Beach said: I have been urged by the Vestry of St. George, Hanover Square, to grant a provisional order allowing a third company to supply electrical energy in the parish, in addition to the two companies already possessing such powers. I am not, however, prepared to interefere with the arrangements made in the metropolis last year after prolonged inquiry, until the companies to whom powers were then granted have been allowed a reasonable time for proving their ability to discharge their obligations, which arrangement was supported by the London County Council. I have, however, informed the companies in question, whose applications, I may state, were last year supported by the local authority, that I should not be disposed to adopt this course another year unless they can then prove that they are in a position to supply energy in the district.

Mill Lighting at Pemberton.—A new mill of 22,000 spindles has been lighted throughout by electricity.

The Edison Company in Boston.—The laying of underground wires by this company is being carried forward with great vigour and on a large scale. It is reported that the company has a very large demand upon it for light and power.

With the Saints.—At an immense mass meeting recently held under the auspices of the Chamber of Commerce, for the purpose of discussing matters for the advancement of Salt Lake City and Utah, it was resolved to request the City Council to grant liberal franchises to electric railway and other public enterprises, several of which are backed by New York and Boston capital to the extent of over 500,000 dollars.

American Humour.—"Give me 2,367," shouted Cumso into the telephone. He repeated the offer six times unsuccessfully, and then Fangle suggested, "Try a smaller number first, and gradually work up."

Central London Railway Bill.—The Select Committee of the House of Commons on the Central London Railway Bill sat on Tuesday for the purpose of going through the clauses of the Bill. Mr. Pember, Q.C., on behalf of the promoters, referred the committee to Clause 35 of the Bill, which provided for the acquisition of the subsoil without compensation, and in place of which the chairman had suggested the substitution of a similar clause to 68 of the Midland Railway Act. He proposed a wider clause than that submitted by the chairman, and which provided that the frontages should receive no compensation for the use of the subsoil, but should be compensated by the company should any damage be done to cellars or other property by the removal of subsoil. Mr. Moorson, on behalf of Mr. Evelin, opposed, but the committee passed the clause as suggested by the promoters. The next question discussed was the amount of capital, and Mr. Pember said the promoters proposed to knock £100,000 off the capital and £33,000 off the borrowing powers, but the committee thought that was not enough, and said that another £100,000 must be knocked off. It was then proposed to consider the opposition of the London County Council, but Mr. Freeman, on behalf of the promoters, said they hoped to arrive at an arrangement with that body. It was further decided that no prospectus should be issued, or capital raised, until the Southwark line had been worked for a period of at least three months. After hearing more arguments, the committee decided that the clause proposed by the council, by which they had power to require the promoters to set their stations back when necessary, was a reasonable one. The opposed clauses having been finished, the committee proceeded to examine those which were unopposed.

Adelaide Royal Agricultural Society.—We are informed that Messrs. Ransomes, Sims and Jefferies, Limited, of the Orwell Works, Ipswich, have been awarded the first prize for their portable steam engines, exhibited at this year's show of the above society. The report mentions, in addition, that the engine to which the award was made was very much admired for its construction and smoothness of working.

Gordon Technical College.—This college, which was established in Geelong, Victoria, in 1885, has recently had an important addition to it in the form of a well-filled chemical laboratory. An electrical and telegraphic class, under Mr. J. A. Dawson, is carried on in the institution, and thorough practical instruction is given on the subjects.

Royal Military Exhibition.—Apart from the electric lighting of this exhibition there are only about half-a-dozen electrical exhibits. These, with one exception, and to which we may refer in a future issue, do not require special mention.

The Phonograph.—Mr. Edison has expressed the opinion that a phonographic record taken to day, and carefully preserved, can be reproduced 250 years hence.

An Exposition Internationale for 1890.—The Société Nationale des Sciences et des Arts Industriels is preparing for a second international exhibition to last from July to November. The Palais de l'Industrie has been chosen for the site, and, mindful of the great successes scored for the electrical industry in the two former exhibitions, it is intended to have the electrical section, particularly the lighting, on a still more magnificent scale. The demands for space from inland and abroad are already considerable. The Exhibition will include some novel types of dynamos, motors, meters, &c., which, owing to incompleteness, could not put in an appearance at the last exhibition. The Comité d'Admission includes the following well-known names:—MM. H. Fontaine, president d'honneur; Boistel, president; Berton, vice-president; Dieudonné, secretary; MM. Boivin, Cance, Carpentier, Hospitalier, Mildé, Monnier, Napoli, Vivarez and Rau, members.

The Telephone in France.—The establishment of inter-urban telephone lines in France up to now has been very restricted. The following is a list of applications for inter-urban communications now under consideration: Lille to Valenciennes (which has been made the object of a provisional agreement); Lyons to St. Etienne (ditto); Lille to Fourmies (asked for since 1844); Aix to Marseilles, Paris to Amiens, Arras, Douai and Lille, Bayonne to Anglet and Biarritz, Bordeaux to Libourne, Béthune to Lille, Caen to Paris, Chambery to Aix-les-Bains, Dieppe to Paris, Elbœuf to Paris, Fontainebleau to Paris, Havre to Fécamp, Lille to Cambrai, Limoges to Paris, Lyons to Grenoble, Lyons to St. Etienne, Marseilles to Nice, Cannes, Mentone and Monaco; Montpellier to Cette, Béziers and Narbonne, Nantes to Paris, Paris to Bordeaux, Saint Quentin to Paris, Tours to Paris, Troyes to Paris, and Nantes to Saint Nazaire. The commission appointed by the Administration of Posts and Telegraphs to study the technical procedure of telephony put up to competition an apparatus destined to long-distance transmission, and from subscriber to subscriber. Twenty models were presented, and experiments were made on a double line from Paris to Brussels, a distance of 678 kilomètres. One of these apparatus was found to be good. The new system employs much smaller wires, which allows of a saving, from Paris to Marseilles, for instance, of 125,000 kilogrammes of copper. The Direction of Posts and Telegraphs intends to make further experiments with 50 of these instruments between Paris, Lille and Marseilles.

The Telautograph an English Invention.—A correspondent writes:—"Statements have appeared from time to time in British newspapers and technical journals with reference to the auto-telegraph or tel-autograph, one of the latest developments of electrical science, which ascribes its origin to an American inventor, Professor Gray. This wonderful instrument, which is to solve the question of sending autograph messages, drawings, and plans by telegraphy, has just been proved to be of British origin, in a case that has been decided before the Comptroller of Patents. The principle of the auto-telegraph consists in actuating the receiving instrument by means of transient electric currents or pulsations, produced at the transmitting instrument by the movement of a pen, and transmitted through the line wires, which currents are utilised at the receiving station to actuate electro-magnets or motors, which move the writing pen. For this invention a patent was applied for by Mr. Thomas O'Brien, of Liverpool, on the 30th of May, 1888, and by Professor Gray of Highland Park, U.S.A., on the 31st of July, in the same year, so that the English inventor has priority of two months. A patent was duly granted to Mr. O'Brien for all the main features of the instruments, and he opposed the granting of the patent applied for by Professor Gray, on the ground that the same invention had already been patented to him. After considerable delay on the part of the American, the case was eventually set down for hearing, and the Comptroller of Patents has decided that the two inventions are practically the same, and has refused to grant a patent to Professor Gray unless he withdraws his principal claim and inserts a disclaiming clause in the specification, to the effect that his patent does not claim or cover anything that is described in the specification of Mr. O'Brien's patent. Thus, his patent, if granted at all, will refer only to minor details of construction, which are of but slight importance. This decision will also have the effect of establishing Mr. O'Brien's rights in the patents granted in foreign countries. Messrs. W. P. Thompson & Co., patent agents, of Manchester, Liverpool, and London, appeared in support of Mr. O'Brien's patent, and Mr. Newton, of London, appeared for Mr. Gray. It is open to Mr. Gray to appeal against this decision if he be so advised, and it remains to be seen what course he will adopt. Mr. O'Brien has now had working instruments prepared, and of these the public will probably hear more shortly, as they are to be exhibited in London in the course of a month or so. It is to be hoped that, now the question of priority is settled, the parties will not waste their time and energies in further litigation, but rather that, if necessary in the public interest, they will amalgamate, so that the community may have the full advantage of the invention as early as possible."

Tunnel Lighting.—Repairs are being made to the arch of the Olimpino tunnel of the Gothard Railway between Chiasso and Como, and, to expedite the work, a temporary electric light installation has been put up. At the southern end of the tunnel, which is 1¼ miles long, is a compound dynamo of the latest Gramme type, and this is driven by belting from the flywheel of a portable locomotive engine and boiler. Insulated cables are run along the roof of the tunnel to 30 lamps, of which about one-third is usually employed. The lamps are movable, and are arranged in parallel.

Dispute as to Period of Contract.—A dispute has been waging for some time past between the Wrexham Electric Light Company and the Corporation. The local body wanted the company to supply the light for 30 years, the company requiring the full statutory period of 42 years. A committee, however, has decided to recommend the Corporation to grant the full period.

Dewsbury Wants the Light.—The Town Council will supply the light, and is anxious to begin laying the mains.

The National Telephone Electrical Society.—This society held its first annual conversazione on Friday evening, the 2nd inst., at the Colonnade Hotel, New Street, Birmingham. Professor J. H. Poynting showed some interesting experiments, of which he was kind enough to give personal explanation. The President, Mr. Alfred Coleman, congratulated the society upon the imposing appearance it presented, and gave some interesting statistics in connection with telephony. He then called upon the honorary secretary, Mr. Wm. Johnston, to read his report, which showed that the society had been a thorough success, and had been the means of keeping alive a spirit of inquiry amongst its members. Mr. W. A. Baxter proposed and Mr. Thos. Clark seconded a vote of thanks to the Vice-President, Mr. Arthur E. Cottrell, who replied in an eloquent speech. Votes of thanks were also accorded to the chairman of the committee, and to Mr. Johnston, the honorary secretary. A programme of music and recitations was then gone through, and the company broke up about twelve o'clock, immensely delighted with the character of the proceedings.

Observatory Tests by Cable.—The *New York Herald*, from Montreal, May 12th, says:—"Greenwich and M'Gill Observatories were placed in direct communication yesterday by means of the Mackay-Bennett cables and the Canadian Pacific telegraphs for the purpose of testing the accuracy of Montreal's longitude. Some eight or ten tests were made, and the actual time of transmission was three-quarters of a second. Had it not been for the repetition at Canso, where the land wire connects with the cables, the time would have been instantaneous, a distance of 4,000 miles. These tests will be continued for several Sundays, and will be made subsequently from Toronto and Vancouver, which are boxed on tests between Greenwich and Cambridge, Massachusetts.

Electrical Ventilator.—The new United States man-of-war, the *Baltimore*, is supplied with an electrical ventilator having a capacity of never less than one cubic metre per second. It is calculated that in two minutes the air in the engine room can be completely changed. It works so quietly that it is impossible to tell whether it is in operation or not.

Damaging the Queen's Private Cable.—In the Queen's Bench, on Monday last, the case of the Attorney-General *v.* Taylor was an information by the Crown against the master of the *Olive Branch*, for negligently navigating his vessel as to damage an electric cable laid in the bed of the Medina River, Isle of Wight, and conveying messages to and from Osborne, one of the residences of Her Majesty. It appeared that the anchor of the defendant's vessel caught in the cable and caused damage which cost £29 to repair, and moreover deprived Her Majesty of the use of the cable. The defendant pleaded not guilty, and contended that the position of the cable was not sufficiently indicated by the buoys placed by the Postmaster-General. The jury took this view, and returned a verdict for the defendant.

Electric Lighting at Königsberg.—The central electric light station at Königsberg has been carried out by the town, under the direction of Messrs. Kreiger and Frühling. There are four tubular boilers and four triple expansion engines, two of 100 H.P., and two of 200 H.P. There are eight continuous current dynamos, and the five-wire system of distribution is used. Copper cables are employed, laid in trenches on the Monier system, which are placed under the foot pavement at a depth of about a yard. Mains have been laid for the supply of 30,000 16-C.P. lamps, but at first there will be only 6,000 lamps. The finishing strokes are being put to the work.

Telegraphy and Telephony in Germany.—Extensive works are being carried out on the German telegraph and telephone systems, and about £400,000 will be spent on them this year. In round figures, £150,000 will be devoted to the extension of urban and inter urban telephony; £100,000 to new telegraph offices in rural districts; £40,000 to improved telegraph wires, new poles, and changing overhead lines into underground lines, and £4,500 to the extension of the pneumatic installations in Berlin and Hamburg.

The Watkin Tower.—Sir Edward Watkin has temporarily entitled his projected tower, the "Great Tower in London," instead of the "Tower of London," under which name it had previously been seen in print, much to the horror of the beefeaters of *the* Tower. The designs which have been on view in the Drapers' Hall, Throgmorton Street, have now been removed, but they will be on public view again elsewhere. There were in all 80 designs. A few of the designers propose electric lifts.

Capital Punishment in America.—The Upper House of the State Legislature has rejected the Bill for the abolition of capital punishment.

Lighting at Clevedon.—The Clevedon (Somerset) Local Board invite tenders for the public lighting of their district, for one, two, or three years. Tenders to be sent to the clerk, Mr. Henry C. Fry, Clevedon, by June 3rd.

Ganz Patents.—The *Lyon Républican* states that the Creusot works have been given the concession in France for the Ganz electrical patents.

The Royal Society's Conversazione.—The Royal Society, on Wednesday last, held their first conversazione of the season at their rooms in Burlington House. The President of the society, Sir Gabriel G. Stokes, Bart., M.P., received the visitors, a distinguished throng, representing every branch of the learned as well as of the militant professions. Among the invited guests was the name of H. M. Stanley, and it was a disappointment to many that he was not able to be present. The exhibits were of an unusually interesting and varied character. A set of apparatus shown by Mr. G. J. Burch and Professor Burdon Sanderson, to illustrate the use of the capillary electrometer, for investigating rapid changes of potential, was on view for the first time, and it is the intention of the inventors to read a paper descriptive of their methods at a forthcoming meeting of the society. It will suffice here to say that a reversal of potential, occupying less than one-hundredth part of a second, can be clearly demonstrated. For physiological purposes a large field of usefulness should be found for the apparatus. Phenomena connected with thunderstorms can be recorded by Mr. S. J. Symons's brontometer, which will on one slip of paper note the commencement, variation in intensity, and termination of rain and hail; the instant of each lightning flash; and the commencement and duration of a thunder clap. The instrument can be read for periods of time down to a fiftieth part of a second. Mr. C. V. Boys exhibited an arrangement to show, either by projection or by photography, the oscillatory nature of an electric spark. Some photographs represented the shadows cast by a water jet upon a rapidly moving plate by the intermittent light of an oscillatory spark. Mr. Shelford Bidwell's experiments of the electrification of a steam jet suggests an explanation of the intense darkness accompanied by a lurid glow, which is characteristic of a thundercloud. An object of general attention was an Egyptian papyrus, supposed to be the oldest medical treatise extant, dating back to perhaps 2,500 years B.C.

Looming in the Distance.—It seems that the time cannot be far distant, judging from the number of attempts now being made to enforce royalties upon electrical patents of all kinds, when we shall see announced the registration of "The United Electrical Patents Blackmailing Company, Unlimited."

Bolton Town Council Lights the Borough.—At a special meeting of the council it was resolved to make an application for a provisional order for the lighting of the town.

Accident on an Electric Railway.—Says a Dalziel telegram of last Monday:—A car on the Pleasant Valley Electric Railway, Pittsburg, became uncontrollable, and, rushing at great speed down a steep grade, came in contact with the preceding car and telescoped it. Two persons were killed.

The Institution of Electrical Engineers.—On Friday last Mr. Müller read a paper on "House Telephones" before the students of the Institution, Major-General Webber in the chair. An interesting discussion followed, in which the chairman, Messrs. Raphael, Horn, Bone, Foyster, and Cross took part. Mr. Stephens will read a paper on "Marine Propulsion by Electricity," on the 23rd inst. This will be the last meeting of the students before the summer vacation.

Personal.—Mr. Slater Lewis writes us from Stechford, near Birmingham, to say that he has left the firm of Buller, Jobson and Company, the scheme to erect telegraph works having fallen through. Mr. Lewis intends commencing business on his own account in Birmingham, and we have no doubt that with his energy and the large experience he has had, will soon make fresh headway amongst his many old friends, all of whom will wish him every success.

The Paris Telegraph Congress.—The Portuguese Government has appointed, to represent it at the Telegraph Congress which is now assembled in Paris, the following gentlemen:—Government Plenipotentiary, the Councillor Senhor Guilhermino Augusto de Barros; Engineer and Technical Delegate, Senhor Paulo Benjamin Cabral; Secretary, Senhor Camillo de Moraes.

Where are the Receipts?—Letters have been sent to the Birmingham papers enquiring for statements as to the financial results of the exhibition held last year. It was said the surplus money was to be bestowed on local hospitals, but the colour has not been seen yet.

Barking Road Electric Cars.—We have received the following letter, which has come too late for our correspondence columns:—"On page 507 of your issue of the 9th inst., in a notice on electric traction, the following words occur: 'With accumulator traction very little has been done except on the Barking line, by Mr. Reckenzaun, and more recently . . .' Now the equipment of the Barking line, with six accumulator cars, is the work of the Electric Traction Company, New Broad Street House, and with this line Mr. Reckenzaun has not been connected, nor is the misstatement his.—THOMAS FRAZER." [With reference to the above, we did not intend to say Mr. Reckenzaun had done work on the Barking Road line, but distinctly stated that work of the kind mentioned has been accomplished by three parties. Our correspondent is evidently suffering from a mental displacement of commas.—EDS. ELEC. REV.]

The Cuba Submarine Company's New Cable.—We hear that the contract for the manufacture and laying of the Batabano cable has been given to Messrs. Hooper's Telegraph Works.

Church Lighting.—A very interesting installation of the electric light is to be seen at the Holy Trinity Church, Sloane Street, Chelsea, which was consecrated on Tuesday last. The lighting arrangements have been planned and carried out by the Brush Electrical Engineering Company, in conjunction with Mr. J. D. Sedding, the architect of the building, and the effect is excellent. The amount of light can be adjusted according to requirements, and all the lights are controlled by switches fixed in a polished oak box with plate glass doors under the gallery. When completed the installation will consist of 130 16-C.P. incandescence lamps, and 102 8-C.P. ditto. The supply of current is derived from the mains of the Chelsea Electricity Supply Company, whose station is situated in Draycott Place.

Art and Electricity.—Messrs. Cooper, of Great Pulteney Street, gave a private view, on Wednesday afternoon, of an exhibition illustrating in a practical manner the artistic application of the incandescent lamps in the way of domestic illumination and adornment. Rooms were specially decorated in various styles, including old oak dining room, Venetian drawing room, Bartolozzi boudoir, music room, and Louis Quinze room. We understand the exhibition will be open to the public till the end of June.

A Warning.—In the interests of the electrical trades we beg to call attention to a special advertisement of Messrs. Woodhouse and Rawson United, Limited, which may put traders on their guard.

A Trifling Mistake.—In glancing through the pages of an American exchange just to hand, we noticed the following: "A New Electric Blower." Thinking that the article was descriptive of one of its contemporaries, we were sadly undeceived when we found that it had reference to a ventilator only.

Foreign Tenders Wanted.—Tenders will be invited in August for the lighting of Sofia, Bulgaria, by electricity, using the water of the Boyena as the motive power.

Strike.—We understand that the workmen in the employ of Messrs. Latimer Clark, Muirhead & Co., have been out on strike during the week. We have not yet heard whether any satisfactory settlement of the dispute, which appears to exist between the works' manager and the men, has been effected.

Electric Lighting in the City.—The House-to-House Electric Supply Company has given official notice of its intention not to proceed any further this session with the Bill deposited for power to light with the electric light an area defined as "The City of London." This Bill (apart from provisional orders) was the only remaining one before Parliament seeking electric lighting powers over any part of London. All the others have been previously withdrawn.

The Joule Memorial.—A meeting of the Joule Memorial Committee was held at the Manchester Town Hall last Monday, the Mayor in the chair, to meet Mr. Alfred Gilbert, A.R.A. At the close of a conversation on the subject of the proposed statue, a resolution was unanimously passed adopting the resolution of the Art Sub-Committee in favour of the bestowal of the commission on Mr. Gilbert, who undertook to execute the work. Mr. Gilbert, after inspecting the Chantrey monument of Dalton in the Town Hall, visited the House of the Literary and Philosophical Society, in George Street, for so many years the scientific home of Dr. Joule, in order to see, amongst other things, the portrait in oil which represents him in the maturity of his powers.

Foreign Trade.—The value of the exports of telegraphic wires and apparatus connected therewith for the month of April, 1888, 1889, and 1890, respectively, was £27,012, £13,032, and £187,733. For the four months ending 30th April, 1888, 1889, and 1890, the the value was respectively £115,089, £444,341, and £512,403. The imports of caoutchouc for the month were £199,213, £145,595, and £251,404; for the four months there were £1,037,262, £1,198,769, and £1,168,186. The imports of gutta-percha for the month were £7,807, £46,185, and £100,588; for the four months they were £40,301, £119,586, and £315,220. The imports of copper ore for the month were £84,095, £74.847, and £71,997; for the four months they were £252,057, £429,725, and £281,623. The imports of regulus and precipitate for the month were £246,976, £147,952, and £198,008; for the four months they were £1,084,620, £1,133,954, and £847,500. The imports of unwrought and part wrought copper for the month were £389,169, £152,857, and £137,216; for the four months they were £1,301,483, £961,488, and £685,763.

The Phonograph in Mexico.—The Mexican Post Office authorities have taken up the phonograph and placed it at the disposal of the public at a charge of six to twelve centimes the 1,000 words. The intending user, having paid the fee, speaks into the machine, after which the cylinder is packed in a case and forwarded to the person addressed, who receives, besides, from the post office, a phonograph which repeats the message, and is then returned to the office. As a large proportion of Mexicans have not yet solved the mystery of reading and writing this method of corresponding is found very serviceable.

Electric Signalling in Mines.—On Saturday, 3rd May, a special monthly meeting of the Midland Counties Branch of the National Association of Colliery Managers was held at Derby, at the works of Messrs. John Davis and Son, when the subject of electric signals for mining purposes was explained, and their mode of working illustrated by the firm's electrical engineer, Mr. Wallis. A discussion followed, and ultimately was adjourned in order that a suitable and effective code of signals might be prepared for the district.

Reducing the Price of the Electric Light to a Minimum.—A young man from Nikopolis, named Verditchewski, had been sent to Paris to study at a technical school. Some benevolent persons supplied him with the means, most of whom lived in Odessa. The young man recently returned there, repaid the money advanced to him, and was very lavish in his expenditure, giving as the reason for his being in possession of so much "that he had discovered an invention tending to reduce to the lowest minimum the cost of the electric light." That invention he had sold to Baron Rothschild for the modest sum of 12,000,000 francs. It was discovered a few days afterwards that a great robbery, amounting to more than a million francs, had been committed in Florence by a young Russian, with the connivance of the hotel keeper, the victim being the wife of a retired ambassador. Verditchewski was at once suspected, and a search for him was promptly instituted.

Code Telegrams at the Paris Conference.— The morning papers say that at the Conference an attempt may possible be made to somewhat restrict the use of code words for telegraph messages, which have become so important a feature in international mercantile operations. The Council of the London Chamber of Commerce has unanimously supported and transmitted two influentially-signed representations to the Postmaster-General and the Secretary of State for India, urging that the representatives both of this country and of the Government of India at the Conference will strenuously resist all proposals that would have the effect of restricting in any way the use for code telegrams of all the legitimate words at present authorised.

Manufacture of Turbines.—Mr. Günther, Central Works, Oldham, is, according to the *Ironmonger*, extremely busy with the manufacture of turbines, and has several very large orders in hand, the most important being one for five "Girard" turbines, intended to drive a total of 1,520 horse-power, under a fall of 74 feet. These turbines, which are intended for a large cotton spinning, weaving and finishing mill, in course of erection near Orizaba, Mexico, comprise two turbines of 425 horse-power each, one of 300 horse-power, one of 250 horse-power, and one of 120 horse-power, the last-mentioned one being intended to drive the electric machinery for lighting up the mill. The turbines will be placed in pits about 70 feet deep, and are being made of extra large diameter, so as to obtain moderate speed, and thus secure the greatest possible efficiency and durability.

Ferranti's High Tension Enterprise.—The *Western Electrician* thinks that we do not possess the humble virtue of patience. The remark was called forth by our editorials on the 10,000 volt scheme at Deptford, and the American journal concludes that we must await the lapse of time before speaking definitely. Americans, says our mentor, will not find in the failure of a few Ferranti cables any cause for discouragement; they will rather regard the failure as something perfectly natural in the execution of a new enterprise. "It must be remembered that Mr. Ferranti is, in one sense, a pioneer, and hence is without the experience of others to guide him." The *Western Electrician* may prefer to be wise after the event, and it is very kind of American electricians to regard the Deptford mishaps in such a lenient manner; but it should not be forgotten that the "pioneer" has been warned over and over again as to the probable manner in which his ambitious designs would end; therefore he cannot afterwards claim that his scheme was purely in the nature of an experiment, for all his much-vaunted insulation tests on various materials had been carried out by others years before, and nothing new has been advanced at Deptford. Should our opinions eventually turn out fallacious, we shall be the first to congratulate Mr. Ferranti on showing us the error of our ways.

NEW COMPANY REGISTERED.

Dunedin Suburban Gas Company, Limited.—Capital £40,000 in £5 shares. Objects: To manufacture and supply gas in the boroughs of Caversham, Roslyn, Mornington and St. Kilda in Dunedin, New Zealand: To provide and supply lighting by means of electricity, and also to supply electrical currents or force for public and private purposes. Signatories (with one share each): Col. W. A Hankey, Beaulieu, near Hastings; H. F. Grimston, 6, Foulis Terrace, Onslow Gardens; T. T. Woolley, 7, Finch Lane; Hy. Berners, 4A, Cork Street, W.; W. Campbell, 19, Portman Square; C. A. Day, Southampton; F. Dutton, 112, Gresham House. The signatories are to appoint the first directors; qualification, £250 in shares or stock; remuneration £200 per annum, divisible. Registered 8th inst., by Messrs. Walter Webb & Co., 23, Queen Victoria Street. Office, 2, East India Avenue, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Automatic Electric Railway Signal Company, Limited.—At an extraordinary general meeting of this company, held at the Exchange Sale Room, Liverpool, on the 7th inst., it was proved to the satisfaction of the meeting that by reason of its liabilities the company could not continue its business, and it was therefore resolved to wind up voluntarily, Mr. J. Harvey Evans, of 11, Rumford Place, Liverpool, being appointed liquidator. The resolution was filed on the 10th inst.

Electric Traction Company, Limited.—The statutory return of this company made up to June 1st, 1888, was

filed on the 7th inst. The nominal capital is £30,000 in £10 shares. At the date of making up 500 shares were subscribed for, seven being fully paid. Upon the remaining 500 shares, £4 per share had been called, the calls received amounting to £2,070.

The annual return of the company made up to July 9th, 1889, was filed on the 7th inst. At the date of the return, 1,832 shares had been taken up, 1,000 being considered as fully paid. Upon the remaining 832 shares the full amount had been called and paid. Registered office, 25 to 35, New Broad Street.

Wrexham and District Electric Supply Company, Limited.—The statutory return of this company made up to the 3rd inst., was filed on the 7th inst. The nominal capital is £20,000 in £5 shares, 50 of which are taken up, but no call has yet been made thereupon. Registered office, Yspythy, 12, Queen Street, Wrexham.

CITY NOTES, REPORTS, MEETINGS, &c.

Maxim-Weston Electric Company, Limited.

THE ordinary general meeting of this company was held at the Cannon Street Hotel on Friday last, Mr. J. B. Gooding in the chair.

The notice of the meeting having been read by the officiating secretary,

The Chairman said he thought the best thing they could do was to adopt the report as it stood. Necessarily it would give rise to some discussion, but that was for the shareholders to determine. He therefore moved that the report as submitted be adopted.

Mr. Thorne thought it was usual to have some explanation of the accounts. He had attended a great many meetings, but had never seen such a course adopted. If such a thing was done they (the shareholders) would be silenced. He moved as an amendment that the chairman be asked to give some explanation.

Mr. Woodhead seconded the amendment.

Mr. Cave said if the matter was going to be rushed through in that manner, he had another amendment to propose. Taking into consideration the report and balance sheet sent out to the shareholders, who were probably of the same opinion as himself, that they were no wiser than before they received it, he considered the best way to obtain the information desired was to appoint a committee of investigation, independent of the present board, and accordingly proposed one, which was seconded.

Mr. Newton asked if the chairman intended giving any information.

The Chairman said it was his intention to give a full explanation.

Mr. Newton: Then why create this hostility.

The Chairman: He was for giving an explicit statement, but had been overruled.

After further observations from shareholders, the Chairman proceeded to say that he found himself in a somewhat anomalous position before them to-day. He was called upon to explain away a most disastrous balance sheet, and a most disastrous state of affairs existing at the present time in connection with the company, and for which he begged to disclaim all responsibility. He was asked to join the board, and they would pardon him if the few remarks he made at the outset were personal, but he wished to explain his position, the only motive which he thought actuated gentlemen in asking him was to get rid of a very obnoxious director; that was the sum and total why he was asked. On becoming a member of the board, he found it was essential in the interests of the shareholders that that obnoxious director should be got rid of, and he was. That gentleman had forfeited his shares, and the directors availed themselves of the opportunity, and declared his seat void. There were other little irregularities, and other matters which he thought in the shareholders interests should be looked after; and he, at the risk of sacrifice of personal interests, from a political point of view, made enemies in connection with the company. The board now was represented only by three members, Mr. Marks, Mr. Couchman and himself. He found inefficient officials, their money squandered in drinks and refreshments, and the most rotten state of affairs it was possible to conceive in connection with the management of the company. He was very sorry to speak in this way, because it appeared somewhat personal to his co-directors. He wished to deny all personal motives, they had acted together in the most harmonious way since Christmas, and they had made gigantic efforts to put the company on a sound footing, but for want of capital and other reasons it had been a most disastrous failure. The report he had to deal with was only up to the 31st December last. As they were aware, up to that time no business practically had been done by the company; hence the lamentable results in the figures before them. Since Christmas they had done a considerable amount of work, but they had inherited from the old company a heritage of litigation which has resulted in the outlay of thousands of pounds, which, with their limited capital, was a source of great detriment to all prospect of doing sound business for the company. Before he proceeded further he wished to warn shareholders against any attempt made on the part of people present for any committees of investigation or committees of enquiry. (Cries of "No, no.") They would not do any good. The company was doomed to bankruptcy; they ought to look it fairly in the face, and a committee would not make them any better. He anticipated some attempt would be made by persons engaged in litigation with the company to get a committee, and so have the company at their disposal. Let him warn them. There were professional wreckers amongst them, the curse of nine-tenths of the companies which went to the wall in this country. A committee of enquiry was their object; there would probably be liquidators' fees. He would ask any gentleman who moved for a committee the number of shares he had in the company, and he hoped shareholders would ascertain how many a proposer of such a resolution possessed. He saw the solicitor present of a person against whom they had an action pending, and who only a few days ago applied for ten shares in the company, he also was interested. The causes of disaster which had overtaken this was the bad debts; they spent thousands over litigation; they had an action pending against Mr. Watt, they had an action with the Brighton Corporation which had cost several hundred of pounds; nothing they had touched had turned out well. They had subscribed a capital of £13,000; the directors would agree with him that it was a mistake to attempt to reconstruct any business whatever on that capital. They had out of that sum an expenditure of £4,000 in salaries, fees, &c.; how could there be any prospect of doing business satisfactorily? He would answer any question which was asked.

Mr. Thorne desired to know what the company was doing at the present moment.

The Chairman: Since October they had established an installation at St. Margaret's Mansions, which was a valuable asset, consisting of about 300 lights. They had testimonials from persons for whom they accomplished work, and several jobs had been completed with great satisfaction, but they had not the capital to enable them to compete for large contracts. He, however, had stated some time ago that he would be no party to squeezing money out of the shareholders. Referring to an article in the *Financial News*, which stated everything in electricity was making great progress, he would ask that paper to show him one electric light company which was paying a dividend. (A Voice: Woodhouse and Rawson; 7½ per cent.). They had been in liquidation twice; perhaps they have paid it out of capital. (Hear, hear.) They had in the current issue a letter which was a tissue of lies from beginning to end. He would ask them to compare it with the report of the committee of enquiry which was appointed to investigate the doings of Mr. Watt. Speaking of the company, it would have to compete against men with some knowledge of electricity; they had next door to them a firm who were subject to none of the expenses of limited companies, such as accountants, solicitors, &c., and these were the men who would render it impossible for electric light companies to pay a farthing dividend. (A laugh.) He gave that as his opinion, and such men swarmed about London.

Mr. Hawkins complained that the chairman had not given his opinion of what should be done in the future, and he could not understand how a man could remain chairman of a company and make the statements that he had heard.

The Chairman considered that such radical changes had been made that he considered it his duty to meet the shareholders. He said it would be well to entrust the dignity of the company to the present directors for another month or two until the action against Mr. Watt was over, to prevent it falling into the hands of a few who were interested in finishing. (Hear, hear.) Beware of professional wreckers, as he had said, and also of a more subtle interest still, represented by the long letter in the *Financial News*. He trusted they would let it remain in their hands for a little while, then they intended calling a special meeting, recommending the shareholders, if necessary, to close the concern.

Mr. Hodgson asked if the patents of the company were valuable. After mentioning that Mr. Cave and Mr. Robins (Mr. Watt's secretary) had called on him with reference to moving a resolution in opposition to the company, he said he believed they had a good property, and considered it a great pity to give way to professional wreckers, and unwise to move in any way to destroy whatever property there was until after the action against Mr. Watt. He concluded with a wish to hear a further statement from Mr. Marks.

Mr. Newton criticised the action of the board with regard to the appointment of Mr. Swaby as manager, and thought no one should undertake a responsible office without special and technical knowledge. He congratulated the directors, however, on the fearless manner in which they spoke of the man who had brought ruin on the company.

Mr. Marks said, with reference to the appointment of Mr. Swaby at £400 a year, that gentleman was the only old director left when the company elected new representatives, and it was necessary that they should have at the office someone who knew the state of affairs. They could not expect Mr. Swaby to attend at the office daily without remuneration, and in his opinion it was a sum to which he was fairly entitled. Mr. Hodgson had appealed to him as to an opinion on the affairs of the company. He was sorry to say he did not agree with the chairman, who first disclaimed all responsibility for the position of the company. Since August last the chairman had the affairs of the company

in his hands. With regard to why the chairman was asked to join the board, it was his (the speaker's) impression until that morning that the object was to relieve him from the position, as he found it imperative that his own affairs should receive attention. After Mr. Gooding was appointed, he was asked to remain on the board until the meeting. He asked the chairman to substantiate the statement that money was squandered in drinks and refreshments, as he had not had the price of a bitter ale out of the shareholders' money; it was the first time he was aware of the money being spent in that manner. He did not agree with the chairman in his remarks about there being no business, and also that they were doomed to bankruptcy. As Dr. Hawkins remarked, why, if such was the case, did they bring forward a resolution to elect additional directors. He was not in favour of going into liquidation nor the appointment of a committee. He thought the better course would be to send in names of gentlemen willing to fill the vacant places on the board; his colleagues would be pleased to elect any gentleman who was nominated by the shareholders. He suggested this, as the new directors could form themselves into a committee of investigation; they would have more powers than a committee. For his own part, he would welcome a committee, as the more it investigated the more credit would the present directors receive for the work done. Referring to the causes of the present position of the company, they had found Mr. Watt on the register of the company holding more shares than he was entitled to. The matter went before Mr. Winney, who upheld the contention of the company; but, unfortunately, he only allowed them £50 costs, and his own came to £48, in addition to which there were counsel and accountants' fees. Crisps's account appeared on the books as a debt for £1,500; they were asked to pay up, they simply acknowledged the demand by counter-claiming for over £2,000 damage sustained through bad workmanship. They went into litigation, and, on comparing agreements, found that the one held by Crisps differed from the one in the possession of the company. The work was done in accordanee with the company's contract, but not with Crisps. They were compelled to compromise, and considered themselves lucky to get £400. The Post Office authorities, for a debt of £1,800, offered £90, and finally compromised with £250. The Brighton Corporation had the light installed at the Pavillion, for which they owed a balance, roughly, of £800. The company applied for payment; the corporation counterclaimed for breach of contract, and for money expended by them in completing the installation that the company was supposed to erect. After discussion, arbitration was agreed to. The claim was established before the arbitrator, but he also found that the corporation was entitled to the amount of money spent to complete the installation, which resulted in £6 in favour of the corporation. The company had to pay costs amounting to £651, finally taxed to £417. Such was the determination of the Brighton authorities, that £413 was paid to technical witnesses, who proved that the work was abominably done. With those matters to deal with, could the shareholders feel surprise that the directore were unable to give proper attention to the ordinary affairs, and push the company in any way. Litigation had, in the early stages, crippled them. He merely mentioned the fact that the present chairman had had the affairs of the company entirely in his hands, and could not therefore disclaim all responsibility for the present position. With regard to getting rid of an obnoxious director, certainly when the present chairman took the chair, differences sprang up which did not improve their chances of getting business. "A house divided against itself cannot stand." There was one thing he might mention, and that was, they had at the present moment estimates out for £18,000 worth of work, of which some had been promised; £700 of it had been lost, an installation at the *Sportsman*, though they were the lowest tenderers, but such a name had been left by the late management, and it was simply owing to the name they deserved. They were only just getting rid of that name. They had one of the finest arc lamps, which had been inspected and pronounced as the finest made up to the present time. He thought everything was in favour of their being able to pull through if they appointed men on the board who could give their undivided attention to the work, and who possessed some technical knowledge, which that board did not. The speaker concluded by advising them not to appoint a committee of investigation but to elect new directors.

The Chairman said Mr. Marks would lead the meeting to suppose that since August, when he (the chairman) joined the board, that everything had been going on in a most friendly way, and that there was no litigation on hand. Was he to be made responsible for actions which were initiated long before he went on to the board. Then, with regard to the statement made as to money being squandered in drinks. When he first joined the Board he was perfectly appalled at the petty-cash book, which amounted to £10 per week, the greater part going in the way suggested. He enquired of Mr. Tough, the works manager, who said they were accustomed to it in Mr. Watt's time.

Mr. Tough said it was in the place of overtime for the men working until 12 o'clock.

Mr. Clenck endeavoured to gain a hearing, but was unsuccessful.

The Chairman said he had no objection to hear him, but he was not then a shareholder.

Mr. Newton: He is a director, and I move that Mr. Clenck be heard.

Mr. Pearson objected to any one being in the room who was not a shareholder.

Mr. Newton's resolution was put to the vote, but was lost.

Mr. Swaby made a speech justifying his action in taking £400 a year.

The Chairman then proposed that the report and accounts be adopted, which was carried.

Admiral Inglefield moved that the directors continue to act for them until the settlement of Mr. Watt's action.

Mr. Marks desired to be relieved from the position of director, but afterwards consented to retain his seat, and Admiral Inglefield's motion was carried.

Mr. Hodgson was nominated a director by the shareholders, as also Admiral Inglefield, who, however, refused to stand.

After the election of the auditors, a vote of thanks to the chairman concluded the proceedings.

The Western and Brazilian Telegraph Company, Limited.

THE nineteenth ordinary general meeting of the company was held at Winchester House on Friday the 9th inst., at noon, to receive the directors' report (printed in our last issue) and accounts for the half-year ended 31st December, 1889, and transact other business.

The Chairman, Mr. W. S. Andrews, said the meeting was, fortunately, not held under quite such adverse circumstances as on the last occasion. Then they were expecting, owing to interruptions, reductions of rates and other causes, an exceedingly bad half-year's traffic, and were threatened with competition both north and south of their system. The opposition cables were not merely projected, but apparently upon the point of being laid. However, the apparent gloom of their prospects had, he was glad to say, been a good deal mitigated. To begin with, the receipts of the half-year very largely increased towards its close. When they last met they were under an empire, and they woke up the next morning, or the morning after, under a republic. In times of political disturbance there was very great activity in the interchange of telegrams, and the receipts of the last two months of the half-year, consequently, had been very high indeed comparatively. Of course the results of the whole half-year compared unfavourably with the corresponding one in which they took the extraordinary total of £110,000, the highest total on their record. Those high receipts were due partly to high tariffs, partly to the high rate of exchange, and partly to the enormous commercial activity and great speculation that prevailed during that half-year. The company nevertheless had managed to scrape together, for the six months ending December, £86,403, no doubt a pretty large decrease compared with the previous high figure, but, he was pleased to say, nothing like so large as they anticipated. As regards expenses; taking those under Abstract A, expenses at stations, the total worked out practically the same as that for the corresponding period, the difference amounting on the gross to only £11 6s. Taking Abstract C, expenses in London, the totals were again closely identical, the difference being only £61 13s. 2d. Those figures, he thought, were satisfactory from the point of view of commercial expenses. The only real increase was under a head which it was extremely difficult to control, viz., ships. The *Norseman*, their own ship, had had to be ordered home, and the *Buccaneer* chartered to replace her. The expenses would not have been so great only that the *Norseman* was detained by the strikes at Leith. Consequently the net increase shown under "ships" was £6,281 9s. 7d. Of course, had the *Buccaneer* not been chartered, the losses in revenue would have been very large compared with the actual amount, as the interruptions happened to be very numerous. Then there was an item of £928 for more cable used, and there was an extra depreciation written off of nearly £809, so that he was correct in saying that the increase in expenses was practically owing to ships and maintenance of cables alone. The repairs to the *Norseman* were very extensive, and had made her almost if not quite as good as she was before, and as her value had been improved by the amount spent upon her, he thought the directors were right in charging the amount to the ship, though, of course, the transit of the ship, coals, wages, &c., had been charged against revenue. All these figures being boiled down, they came to this, that, including the amount, £4,072 9s. 8d., brought forward, and that of £7,379, the dividend received from the Platino Company, the balance to the credit of the revenue account was £57,462 18s. 6d. From this they had to deduct £13,500 for debenture interest, £7,500 for the renewal fund, and £5,600 for the debenture redemption fund, leaving an available balance of £30,862 18s. 6d., which allowed a dividend of 4 per cent. per annum, free of income tax, for the year, and left £3,248 16s. 6d. to be carried forward. They remembered that when they last met they were discussing the steps they ought to take with the Brazilian Government, and, of course, their movements had been rather hastened by the change of Government which had subsequently taken place. In a crisis of that kind they thought that weight might be brought to bear upon the new Government, and therefore the directors sent their papers to the English Government with a request for aid. The British Government he had always found a very difficult one to influence. If they could convince the British Government, they might be sure that their case was not a bad one; and he was glad to say that the result of the Government's investigations was that they were persuaded that the company's case was a very good one. In the end, the British Minister at Rio had been instructed to give his support to the petition and claims sent in to the Brazilian Govern-

ment under the concession and otherwise. The only way in dealing with independent Governments was by suasion, and by getting together as good a case as possible. The directors had given all the information they could, fairly and squarely, and they believed they had a good chance of success, although it was impossible to foretell what might happen. They remembered also that when they last met they were threatened by two competitive lines; one of them was a line from the Argentine territory to Europe, and, although perhaps they felt no very great surprise at the extraordinary schemes put forward by promoters for the purpose of depleting the pockets of the public, still this scheme had caused surprise, because the Argentine Confederation had plenty of cable communication. It had one by the east and one by the west coast already; they were competitive cables, and therefore enjoyed every apparent certainty of being at no time interrupted. Still the Argentine Government thought it would like to have a cable of its own to Europe. They proposed to spend upwards of two millions, and they guaranteed 5 per cent. upon this at a time when the premium upon gold in Buenos Ayres was somewhere at 105. However, the political storm in Brazil rather affected the state of things for the Argentine Confederation, and the premium on gold, instead of going down, continued to go up. The speaker thought he remembered seeing it within the last six weeks somewhere nearer 300 than 200. To guarantee 5 per cent. on two millions of money with gold in the country at a premium of 270 or 280 appeared to have been regarded as extremely difficult, and, so far as he understood, there was no prospect that this cable, which nobody wanted, would come before the public within any recent period. The other scheme was for a cable between Brazil and the United States of America. That was a somewhat smaller scheme; but as they, the Western and Brazilian Telegraph Company, held under their concession that the new cable could only serve for a very limited portion of the traffic, and it could not possibly pay with that small traffic, if the company made good its contention. There being, moreover, no guarantee in its case, the scheme appears to have fallen into the background, although it looked very forward at the time of their last meeting. They might, therefore, hope that these schemes might eventually fall through. The mischief was in these cases that the public seemed always ready to waste capital upon useless cables, and seemed rather to relish being phlebotomised for the benefit of the ubiquitous promoter. Alluding to the forthcoming Telegraphic Conference, he said all the companies would be represented there. He did not know that there was anything to fear from it with regard to the extra European rates. His impression was that much would not be done to affect their rates. As regards the current state of things, of course it did not belong to the half-year under review, but doubtless they would like to know that their receipts in the present half-year were, on the whole, very satisfactory. As far as the year had gone, it promised to be a particularly good one; their receipts were averaging better than they had done in the corresponding period of 1888 by some £6,800, and that with a lower rate of exchange; and, as compared with 1889, there was also a satisfactory increase of £425. He moved the adoption of the report and accounts, and the payment, on the 15th inst., of a dividend of 6s. per share, free of income tax, making 4 per cent. for the year.

Mr. H. Weaver seconded the motion.

A Shareholder wanted to know whether £9,000 had been paid merely for repairing the boilers of the sloop; also what amount of cable had been laid.

Mr. Peto, as regards debentures, said he, personally, would be willing to accept much less interest if he could have permanent stock. He had been told by the company's solicitor that there were legal difficulties in the way of this; but he (Mr. Peto) hoped some way would be found to convert the debentures into debenture stock.

The Chairman explained that it had always been the regular practice to depreciate the ships every year, usually at the rate of 6 per cent. In the present case, having charged a considerable renewal to the value of the *Norseman*, the directors thought proper to extend the figure, and to depreciate the vessel by 10 per cent. The money had not all been spent upon boilers; the ship had been thoroughly overhauled, and had undergone a careful survey. The extent of cable put into the sea by her was 284 miles. As regards the debentures, the directors had endeavoured to get the best advice, and had been told they must not take any steps in the matter, irrespective of the legal difficulties.

The motion was then put and carried unanimously. Messrs. C. W. Earle and H. Weaver were reappointed directors, and Messrs. Jno. Weise and J. G. Griffiths auditors of the company, the latter gentlemen at a joint remuneration of 100 guineas.

The Chairman said, as regards Press rates, that the directors would shortly be in a position to announce a reduction.

Mr. Peto, who said the company was a very fine property, and that the shareholders ought to be thoroughly pleased with the way in which it was managed, moved a vote of thanks to the board, which was carried *nem. con.*, and the meeting broke up.

The West Coast of America Telegraph Company, Limited.

THE 13th ordinary general meeting was held on Wednesday, at Winchester House, at one o'clock, to receive the directors' report (copied into our last issue) and accounts for the 12 months ending December 31st.

The Chairman, Mr. Alfred Marshall, referring to the revenue account, said the company's gross earnings had been £83,568 1s. 9d. This very handsome amount was the result of very considerable traffic during the year, attributable to very good business on the West Coast, also to the formation of a large number of joint stock companies, whose large speculations in nitrates had given the company a great deal of work, and also to the partial interruption of the line on the East Coast, which usually competed for the traffic from Valparaiso. As regards the interest account, he explained the apparent anomaly of there being a smaller balance shown, notwithstanding the comparatively large amount invested in the reserve fund, as due to the account not only showing the dividends earned, but also to the fact of there having been deducted from it discounts paid on remittances coming home. In 1889 a much larger amount of bills had been discounted. Moreover, in 1888 the sum shown included profit earned on sale of stock and re-invested—profit which the year under review had not earned. The year 1888 also included dividends which had been received before the close of the year, and which for the year 1889 had only been received in January and would therefore appear in the next year's account. As regards the West Coast expenditure account, the expenses were some £3,000 higher, owing to a greater amount of work necessitating larger staffs, extension of offices, payment of clerks' passage money, &c. Referring to the very large sum of £25,000 added to the reserve fund, and to the threat of competition, he explained that the company's concession was not a monopoly, but only a permission from the Chilian Government to work the cables, and that Government had only exercised its right in permitting other companies to lay parallel cables. In the course of the year the Central and South American Telegraph Company sent out a repairing steamer of its own, so that the company's agreement with them, and the retaining fee paid by them, would continue no longer. Last month there appeared in the *New York Chronicle* a notice that the Central Company had asked its shareholders for an increase of capital to the extent of one million dollars in order to lay cables parallel to theirs. About the same time that company sent them notice that their joint working agreement, made in July, 1882, and which was terminable by six months' notice, would expire on the 1st October next. This notice came only a few days before the issue of the present report; hence the rather curt reference to it contained in the latter. He thought it not possible that the cable would really be laid by the 1st October, but it was quite possible for it to be manufactured, sent out and laid before the present concessionaire's right expired in February next. He trusted that before the American Company took this serious step some new working arrangements might be made, and he and his colleagues were quite prepared to treat with them. He moved the adoption of the report and accounts.

In reply to a shareholder he said the new company would interfere with the company's traffic with Europe. He did not know whether the million dollars referred to were already raised, but that there were some influential persons connected with the scheme. If the scheme should be persevered with, it would be open to the company to send its messages across South America instead of through Galvaston. Suppose the new cable made, the company would have to try and get some European traffic by the competing route, and would also compete for local traffic, which would mean a reduction of rates. The directors were quite alive to their obligation to do all they could to protect the shareholders' interests. There was no doubt that the competition was a genuine one, and that the alarm was well founded. The other company's attitude was neither conciliatory nor hostile, but rather one of declining to answer.

A Shareholder thought £1,475, the directors' allowance, rather a large amount to divide between three directors, seeing that the work must be very small, and there was no personal responsibility.

Another shareholder suggested the advisability of strengthening the board.

The Chairman explained that the directors were always ready and willing to work. They had the strengthening of the Board in view and were negotiating with a thoroughly competent person to join them.

The motion was then put and carried.

The Chairman then moved to declare a final dividend of 6 per cent. per annum, free of income tax, making 6 per cent. for the year 1889, payable the 21st May. He expressed the hope that the large amount added to the reserve fund would strengthen the company's hands in any negotiations which might take place. The dividend of 6 per cent. per annum was not bad on the whole.

The motion was carried unanimously.

The retiring directors and auditors were re-elected for the year and with a vote of thanks to the chairman and directors the meeting broke up.

TRAFFIC RECEIPTS.

The Brazilian Submarine Telegraph Company, Limited. The traffic receipts for the week ended May 9th, amounted to £2,896.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending May 2nd, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,515; for May 9th, £2,985.

SHARE LIST OF ELECTRICAL COMPANIES

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation. (May 8.)	Closing Quotation. (May 15).	Business done during week ending May 15, 1890.	
£					Highest.	Lowest.
250,000	African Direct Telegraph, Ltd., 4 p. c. Deb. Regd. and to Bearer	100	98 —101	98 —101		
1,549,160	Anglo-American Telegraph, Limited	Stock	50 — 51	50 — 51		
2,725,420	Do. do. 6 p. c. Preferred	Stock	85½— 86½	85 — 86	85⅞	85
2,725,420	Do. do. Deferred	Stock	15⅝— 16	15⅛— 15⅜	15⅛	15
130,000	Brazilian Submarine Telegraph, Limited	10	12¼— 12⅜	12 — 12⅛	12⅛	12¼
99,000	Do. do. 5 p. c. Bonds...	100	101 —103	101 —103		
75,000	Do. do. 5 p. c. 2nd Series, repayable June, 1996	100	105 —108	105 —108		
63,416	Brush Electric Engineering Ordinary, Nos. 1 to 63,416... ...	3	2¼— 2½	2¼— 2½	$2\frac{3}{16}$	...
63,416	Do. do. Preference, Nos. 1 to 63,416 ...	2	1⅝— 1⅞	1⅝— 1⅞	$1\frac{5}{16}$	...
224,850	Consolidated Telephone Construction and Maintenance, Ltd. ...	14/-	$\frac{9}{16}$— $\frac{11}{16}$	$\frac{9}{16}$— $\frac{11}{16}$		
20,000	Crompton & Co., Limited, 7 p. c. Pref. Shares, Nos. 1 to 20,000	Stock	5¼— 5⅜	5¼— 5⅜		
16,900	Cuba Telegraph, Limited	10	11 — 11½	11 — 11½		
6,000	Do. do. 10 p. c. Preference	10	17½— 18½	17½— 18½		
12,931	Direct Spanish Telegraph, Limited ... (£4 only paid)	5	3¾— 4¼	3¾— 4¼	3¾	...
6,000	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10		
60,710	Direct United States Cable, Limited, 1877	20	10⅛— 10⅜	10⅛— 10⅜	10⅜	10⅛
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	13⅞— 14⅛	13⅞— 13⅞	14	13¾
70,000	Do. 6 p. c. Preference	10	14¾— 15¼	14¾— 15¼	15¼	15
200,000	Do. 5 p. c. Debs. (1877 issue), repay. Aug., 1899	100	107 —110	107 —110	108½	...
1,200,000	Do. 4 p. c. Mortgage Debenture Stock	Stock	107 —110 xd	107 —110	109¼	107½
250,000	Eastern Extension, Australasia and China Telegraph, Limited	10	14 — 14¼	13½— 13¾	14⅛	13 11/16
320,000	Do. 6 p. c. Debentures, repay. February, 1891	100	100 —102	100 —102	102	...
446,100	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. ...	100	103 —106	103 —106		
12,500	Do. 5 p. c. Debentures, 1890, redeem. ann. drawings ...	100	97 —100 xd	103 —106		
367,900	Eastern and South African Tel., Ltd., 5 p. c. Mort. Deb., 1900...	100	102 —105	102 —105	104	...
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	4⅜— 5⅛	4⅜— 5⅛		
46,700	Elmore's Patent Copper Depositing, Ltd., Nos. 23,001 to 70,000	2	5 — 5⅛	5 — 5⅛	$5\frac{7}{16}$	5⅛
19,700	Fowler-Waring Cables, Nos. 301 to 20,000 ...(£3 only paid)	5	2¼— 2⅜	2¼— 2⅜	$2\frac{9}{16}$	...
180,227	Globe Telegraph and Trust, Limited	10	8¾— 9	8⅝— 8⅞	$8\frac{15}{16}$	8⅝
180,042	Do. do. 6 p. c. Preference	10	14⅜— 15	14⅜— 15	14⅞	14⅜
150,000	Great Northern Tel. Company of Copenhagen	10	15½— 16 xd	15⅛— 16	15⅝	15½
40,000	Do. do. 5 p. c. Debs. (issue of 1881) ...	100	102 —105	102 —105		
250,000	Do. do. do. (issue of 1883) ...	100	104 —107	104 —107		
9,334	Greenwood and Batley, Ltd., Ordinary, Nos. 4,667 to 14,000 ...	10	12½— 13½	12½— 13½		
5,334	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	11 — 12	11 — 12		
41,600	India-Rubber, Gutta-Percha and Telegraph Works, Limited ...	10	18 — 19	18 — 19	18⅝	18⅜
200,000	Do. do. 4½ p. c. Deb., 1896...	100	103 —105	103 —105		
17,000	Indo-European Telegraph, Limited...	25	38 — 40 xd	38 — 40	39½	...
38,348	London Platino-Brazilian Telegraph, Limited	10	6 — 7	6 — 7 xd		
100,000	Do. do. do. 6 p. c. Debentures ...	100	107 —110	107 —110		
49,900	*Metropolitan Electric Supply, Limited, Nos. 6,101 to 50,000 ...	10	5½— 5⅝	5½— 5½	5½	...
386,875	National Telephone, Limited, Nos. 1 to 386,875	5	5⅜— 5⅞	5⅜— 6	6	5 11/16
49,825	Do. New Nos. 386,876 to 436,700	5	5½— 6	5½— 5¾ xd	5⅝	$5\frac{7}{16}$
15,000	Do. 6 p. c. Cum. 1st Preference	10	12¾— 12⅞	12½— 12⅝	12⅝	...
15,000	Do. 6 p. c. Cum. 2nd Preference (£8 only paid)	10	10 — 11	10 — 11		
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11/- only paid)	1	¼— ⅜ xd	¼— ⅜		
9,000	Reuter's, Limited	8	7½— 8 xd	7½— 8		
209,750	South of England Telephone, Ltd., Ordinary, Nos. 1 to 2,000, 2,501 to 3,500, 93,251 to 300,000	1	¼— ⅜	¼— ...		
20,000	Do. 6 p. c. Cum. Pref., Nos. 1 to 20,000 (£3¼ only paid)	5	3¼— 3⅜	3¼— 3⅜		
3,381	Submarine Cables Trust	Cert.	110 —115	110 —115	114	...
78,949	Swan United Electric Light, Limited ... (£3½ only paid)	5	4½— 5	4⅞— 5¼	5¼	5⅛
37,350	Telegraph Construction and Maintenance, Limited	12	44 — 46	44 — 46	45⅞	44⅞
150,000	Do. do. do. 5 p. c. Bonds, red. 1894	100	101 —104	101 — 104		
55,000	United River Plate Telephone, Limited	5	4½— 5	4½— 5		
146,000	Do. do. 5 p. c. Debenture Stock... ...	Stock	90 — 94	90 — 94		
100,000	Do. do. 7 p. c. Debs., Nos. 1 to 1,000 ...	100	... ...	... ...		
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	9 — 10	9 — 10		
300,000	Do. do. do. 5 p. c. Debentures	100	99 —102	99 —102	101	100¼
30,000	West Coast of America Telegraph, Limited	10	6½— 7½	5½— 6½	6½	6 1/16
150,000	Do. do. do. 8 p. c. Debs, repay. 1902 ..	100	117 —122	117 —122	118	...
64,572	Western and Brazilian Telegraph, Limited	15	10½— 11	10 — 10½ xd	11	10⅜
26,986	Do. do. do. 5 p. c. Cum. Preferred	7½	6½— 7	6½— 7	6⅝	6⅜
26,986	Do. do. do. 5 p. c. Deferred	7½	4 — 4½	3⅞— 4½	4¼	...
200,000	Do. do. do. 6 p. c. Debentures "A," 1910 ..	100	106 —109	106 —109		
250,000	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	104 —107	104 —107		
88,321	West India and Panama Telegraph, Limited	10	2⅜— 2⅝	2⅜— 2⅝	$2\frac{9}{16}$	2⅜
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	11½— 12	11½— 11¾ xd	11¾	11½
4,669	Do. do. do. 6 p. c. 2nd Preference ...	10	14 — 15	12½— 13½		
1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mort (Building) Bonds	$1,000	120 —125 xd	120 —125		
179,300	Do. do. 6 p. c. Sterling Bonds	100	99 —101	99 —101		
42,853	*Westmstr. Elec. Sup. Corp., Ord., Nos. 101 to 42,953 (£2 only paid)	5	1½— 2	1½ - 2	2	...

* Subject to Founders Shares.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Blackpool Electric Tramway Company, Limited, £10 (£6½ paid), 6¼—7⅛.—Electric Construction Corporation (£10 paid), 9¼—10¼.—House-to-House Company (£5 paid), 5—5⅛.—London Electric Supply Corporation, Ordinary (£5 paid), 2½—3.—Manchester Edison and Swan Company, £9, (£1 paid), 11/- —12/-.

BANK RATE OF DISCOUNT.—3 per cent. (17th April, 1890).

ELECTRIC TRACTION DATA.*

By A. RECKENZAUN.

(*Concluded from page* 528.)

Numerous journeys were made through the city with this car, and some days after the above event I took again careful readings; the driver was more experienced, less nervous, never used the utmost electrical power at his disposal, and the average current during two round trips came to only 23·11 ampères. Twenty-five per cent. less than formerly, under similar conditions of load, speed and weather. Although the average height of the peaks was less in this case, the number of them was nearly the same, and the gaps representing periods when no current was used gave, on being added up, 45 per cent. of the total. Thus for nearly half the time the car was running by momentum alone. It must be remembered that every few hundred yards there is a street crossing those we ran on, and all these streets have their tramways, so that for common safety it was necessary to slacken down at each square or block of buildings, even when other traffic and passengers did not impede our progress. These diagrams teach us two important lessons; one is, that a skilful driver can economise energy to a large extent; the other, that proper appliances for regulating the power within a wide range, are a distinct advantage.

After a good shower of rain the tram rails assume a tolerably clean appearance; the mud is then easily squeezed out by the flanges of the car wheels; thus I have observed that during, or immediately after a rainfall, the energy necessary for propelling a vehicle is considerably less than in dry weather. There is a positive saving of power amounting to from 15 to 50 per cent. with clean wet rails. By careful observations we were enabled to record the effect of various comparatively small obstacles on the rails, the ammeter showed the minutest variations in tractive force; it is far more reliable than a dynamometer, since it has neither friction nor momentum.

Snow is the greatest enemy of tramways, it offers the greatest resistance to traction. Anticipating snow storms which occur rather frequently in some parts of the States, we fitted the experimental car with a snow plough and wire brushes. The plough shears were supported by a balanced frame underneath the front platform of the car. These shears could be raised and lowered by foot pressure. Behind the plough shears and just ahead of the front wheels of the car were brushes made of steel wire, and these were kept scraping over the rails by their own weight. The plough served the purpose of removing the bulk of the snow, and the brushes swept the rails and grooves clean in front of the wheel flanges. One day when it snowed very hard, and when the rails were covered about a quarter of an inch deep, we ran the car out upon the experimental track, using in the first instance merely the wire brushes and a little sand on the steepest gradient. It took 2 minutes and 8 seconds to run once round the track, which was soon cleared of snow, taking a mean current of 50 ampères. Snow fell hard all the time, yet it required only 35 minutes to make 20 successive trips, with an average of 30 ampères. In the course of four hours the snow was nearly 2 inches deep, when the car was again started. The brushes alone were of no avail, and the snow plough had to be applied. The first journey was made in 2 minutes and 20 seconds, but with the enormous expenditure of 80 ampères; each succeeding trip, however, took less time and energy, until it reached nearly to its normal value corresponding to clean rails. This would show that with proper appliances, and with cars rapidly succeeding each other, the track can be kept clear; but the accumulation of much snow in the first instance occasions a fearful demand of energy, and without plough and brushes the snow is compressed by the wheels and renders progress almost impossible.

Recent tests made by a commission on the Frankfurt-Offenbach Electric Tramway, which has been in constant operation for six years gave the following results:—Two cars, one of which contained the motor, the other an ordinary car attached to it were taken over the line. The motor car weighed 4 tons, the ordinary car 2 tons, and 20 passengers 1½ tons, giving a total of 7½ tons. Measurements with an ampèremeter were made every 5 seconds. The electromotive force varied between 240 and 300 volts. At starting the current used was 80 to 100 ampères, which fell to 40 in 10 seconds, and the mean current on the level road at 8 miles an hour fluctuated between 15 and 25 ampères. On a gradient of 2·85 per cent. 55 to 60 ampères were recorded, and the mean current over a distance of one mile occupying 7 minutes was found to be 21·48 ampères, and this included four stoppages. The highest amount of energy recorded at any moment, when starting, was 21,700 watts.

Dr. Louis Bell, in an interesting paper published a few month ago, gave the results of his experiments on the La Fayette Road (Ind.), from which I take the following instructive figures. Experimental runs were made on a level road with a car and passengers weighing together 8,200 lbs.

Miles per hour.	Volts.	Ampères.	Electrical H.P.
7·5	404	9·5	5·15
9·3	416	10·4	5·79
9·1	393	10·7	5·40
10·9	434	16·1	9·35
12·4	433	15·4	8·93

Another test on a gradient of 6·58 per cent. rise, one-tenth of a mile in length, gave the following results:—

Miles per hour.	Volts.	Ampères.	Electrical H.P.
2·73	347	27·2	12·65
4·20	403	27·4	13·47
9·30	409	31·3	17·14
6·20	365	32·4	15·85

These results are remarkable when compared with those on the level road; considering the steep gradient, one would have expected a much larger consumption of energy at the necessarily low motor speed. On the other hand, the tractive force on the level road appears to be abnormally high at all speeds when the motor efficiency should be at its very best.

More recently Mr. O. T. Crosby published some interesting data concerning three American tramways which, like those of La Fayette, were worked by overhead conductors. The average expenditure of energy on one car on each of the following lines was:—

	Watts.	Electrical H.P.	Load.	Average speed.
Richmond	4,883	6·5	8,500	6 miles
Cleveland	4,986	6·6	9,500	9 ,,
Scranton	5,587	7·4	9,500	5·7 ,,

The maximum gradients were given to be at Richmond 9 per cent.; at Cleveland "very slight;" and at Scranton 7 per cent., involving maximum expenditures of power of 25·6 H.P., 15 H.P. and 19·2 H.P. (electrical measurements on cars) respectively.

Dr. E. Hopkinson ascertained the mean tractive force on the Bessbrook-Newry Tramway, and he showed that it amounted to 28·9, 27·4 and 37·1 lbs. per ton of gross load hauled during three journeys. The increase in the third journey is due to the mean speed having been nearly doubled. The gradients are not severe in this case, but continuous in one direction.

From numerous sources at our disposal we find that the mean tractive force may be anything from 30 to 50 lbs. per ton, and that it is seldom, if ever, below 20 lbs. on level roads excepting under very favourable circumstances.

All these figures point to the fact that the mechanical resistances on existing tramways are very great, and that even a slight reduction at a comparatively small cost would bring about a considerable saving in traction expenses. By reducing these resistances we not only save power with existing appliances, but by virtue of a smaller demand of tractive force we are enabled to utilise lighter motors, lighter gearing, lighter storage batteries, which, in their turn, again require less for their own propulsion until a practical limit is reached.

Assuming, *a priori*, high efficiency in electric motors and gearing, improvements as regards mechanical resistance on tramways may be looked for, and, I hope, attempted in the following points:—

1. Solid, well fixed, parallel rails.
2. Perfect cylindrical wheels, with thin flanges, or some of them without flanges.
3. Clean rails. The grooves may be swept and watered several times a day by a vehicle especially fitted for this purpose.
4. Sufficient flexibility in axle boxes to allow of free movement in curves.
5. A reasonable number of graduations in the motive power regulated by a switch.
6. Skilful driving, which should occasionally be proved by careful tests and power curves.
7. Automatic sand boxes on steep gradients where the natural adhesion is insufficient.

In conclusion I will repeat that a frequent and judicious use of the ammeter on electric cars will amply repay you for the trouble; it will be the means of great improvements, in the same manner as the indicator diagram enabled us to study the nature of steam engines, and which has been the most direct means of effecting great economy in working.

* Paper read on Wednesday, April 30th, before the Old Students' Association of the City and Guilds of London Institute.

Telegraphy in Russia.—According to the British Consul at Taganroy, a movement is on foot to establish telegraphic communication with Taganroy roadstead.

ELECTRIC LIGHTING OF CANTERBURY.

LAST Wednesday week the lighting of the town came up for discussion at the weekly meeting of the Town Council. The following letter was read from the Brush Company, showing the terms on which they are willing to light the town. Afterwards it was decided to appoint a committee to confer with the company and finally report:—

"We would propose to carry out the lighting of the public streets and thoroughfares by means partly of arc lamps of 1,200 candle-power each in the main and important thoroughfares, and partly of incandescent lamps of 64 candle-power each in the less important thoroughfares. Our proposal includes the lighting in this manner of all the streets and public places contained within the area shown upon the plan forwarded to us, which we now return.

"We have marked on the plan the positions which our electric lamps would occupy, the arc lamps being represented by a blue circle, and the incandescent lamps by a red circle. It will thus be seen that the total number of lamps which we would propose to instal is 36 arc lamps and 149 incandescent lamps.

"We have now, therefore, the pleasure of submitting the following formal proposal to your council:—

"We will undertake the public lighting of Canterbury with arc and incandescent lamps, substantially as shown on the plan returned herewith for a period of 21 years, but determinable at the option of either party after a period of 7 or 14 years, provided your council give to our application for a provisional order to be made in the coming Session of Parliament their assent, and do not give their assent to any rival application for a provisional order, and provided also the period of our provisional order shall not be affected by the determination of the proposed contract between your council and this company in regard to public lighting. These conditions are similar to those which form the basis of our contract with the Hon. Commissioners of Sewers of the City of London.

"Pending the grant of the provisional order, we would apply to the Board of Trade for a license under which we should be enabled without much delay to commence the necessary works for carrying out both the private and public lighting.

"It is probable that in order to localise the capital invested by us in the electric lighting of Canterbury, and thus to facilitate the eventual purchase of the undertaking by your council, and in order also to obtain local co-operation and support, we may find it advisable to apply for a provisional order or license in the name of a local company to be registered by us.

"As regards the public lamps, we would propose that half the lamps should be kept alight all night, while the remaining lamps (which would be placed alternately with the all-night lamps) should be extinguished at midnight.

"We would supply the public lamps at the following charge to your council:—

"£26 per annum per arc lamp alight all night till sunrise.

"£15 per annum per arc lamp extinguished at midnight.

"£13 per annum per incandescent lamp alight all night till sunrise.

"£8 per annum per incandescent lamp extinguished at midnight.

"This will make the total annual cost for public lighting approximately £2,000 per annum.

"Although this cost may be somewhat in excess of that now paid for lighting, it will be borne in mind that the streets will be far more efficiently lighted, probably to the extent of three to four times the amount of light.

"The maximum price at which private lighting would be supplied would be specified in the provisional order and you will understand that inasmuch as we shall not be in any sense in the position of holding a monoply of general lighting, but in that of competitors with the existing gas lighting in Canterbury at 2s. 10d. per thousand feet, it will obviously be necessary for us to supply electric light to private consumers at such a figure as will make it acceptable to them when compared with gas at its present low price.

"The ratepayers will therefore have every guarantee that we shall not charge exorbitantly for the light and as regards the purchase of the undertaking, you are aware that the Act provides that the local authority shall have the right under conditions to acquire the undertaking at the end of 42 years, and we would be willing either to leave this point unchanged in our provisional order, or to agree that your Council shall have the option of undertaking at the end of 21 years by special agreement or arbitration, should this be considered desirable by your Council.

"At the same time we would point out that Parliament having fixed the terms upon which electric lighting undertakings should be acquired by local authorities with due regard to the interests of ratepayers, the Board of Trade are averse to any alterations being made."

Glow Lamps in France.—Mr. Vice-Consul Lee Jorton, of Dieppe, writes that an important new industry has been started and developed at Saint Nicholas, five miles from Dieppe, by English enterprise and capital. This is the manufacture of electric incandescent lamps, in which business several English workmen are employed.

PROCEEDINGS OF SOCIETIES.

The Institution of Electrical Engineers.

"On Lightning-guards for Telegraphic Purposes," and "On the Protection of Cables from Lightning." With Observations on the Effect of Conducting Enclosures. By Dr. OLIVER LODGE, F.R.S., member. (Paper read 24th April, 1890.)

In the paper which I read before the Institution last year, I spoke at length and showed some experiments on the subject of the protection of buildings from lightning; but although there were a few sections in that paper, as ultimately printed, dealing with lightning protectors for telegraphic instruments and cables, yet time prevented my calling attention to this portion of the subject at the meeting, or of showing any experiments in connection with it.

The present communication may be regarded as a development of this omitted but important branch of the subject.

I do not know whether I shall escape controversy this time, but I have no wish to provoke it; and I wish entirely to avoid decrying the merits of other specific protectors in order to emphasise the advantages of my own. All I have to say on this head will have a quite general application, and amounts to about this: that whereas all protectors proceed on the admitted fact that the greater portion of a sudden flash prefers to jump an air space, rather than traverse a moderate length of wire, the cause of this well-known fact was but imperfectly appreciated; could not, indeed, be perfectly appreciated without recognising the rapid oscillatory character of sudden discharges, and the doctrine of impedance, or immense obstruction which good conducting wires offer to currents of this character; an impedance, it may be, of 100 or 1,000 ohms, whereas the resistance to steady currents may be but a ten-thousandth part of this amount.

In a word, the complete theory of lightning protectors has not till recently been known, and accordingly the many ingenious devices which are in use are naturally deficient in details which a completer recognition of theory would have suggested.

Long ago it was shown by the experiments of M. Guillemin and Professor Hughes that existing lightning protectors were not perfect safeguards, inasmuch as they could not protect a fine wire from deflagration by a Leyden jar discharge. At the same time it was admitted by these experimenters, and is, I understand, a matter of common experience, that almost any lightning protector is better than none at all, and that the best of those in use are by no means inefficient instruments. They do not afford perfect security, but the occasions when they partially fail are perhaps not very numerous. It is therefore the practice to establish some sort of proportion between the elaborateness of the protector and the value of the apparatus to be guarded. In telephone exchanges a simple double comb is used. In telegraph offices a pair of plates finely adjusted close together is the form employed, while at cable stations the most elaborate kind of protectors, and often a number of different ones in combination, are arranged, because of the enormous interests at stake.

In electric light installations, on the other hand, it is customary, I believe, at present to use no protector at all. But I cannot suppose that this will much longer be regarded as a reasonable procedure. When one considers the extensive ramifications of conducting leads which are rapidly growing up, and the liability of the neighbourhood of house lightning conductors to some portion of such ramification, it is apparent, I think, that lightning arresters are just as important for electric light leads as for telegraph wires. However, there is no need for me to emphasise this assertion, for I expect that before long a flash from somebody's lightning conductor getting into some electric light leads and burrowing underground throughout a district will do an amount of damage sufficient to eloquently call attention to the danger. At Peterhouse, Cambridge, lightning got at the gas engine, thence to the dynamo, and thence into the leads, where, I believe, it did little more than fuse a large number of cut-outs. But it is not likely always to spare the lamps in so considerate a manner; while danger of an altogether more disastrous kind can by no means be considered absent.

Returning from this digression to the telegraphic protectors at present in use, my contention is that, in all except the very simplest and crudest form of protector, a perception of the true conditions may lead to more complate protection without necessarily much increase in cost. And, proceeding to cases where cost is altogether a secondary consideration, and supposing it possible that telegraph engineers are fairly satisfied with the quality of the protection at present supplied to submarine cables, I would ask them (not pretending to know anything at first hand about the matter) whether a number of obscure and unexplained faults do not develop themselves in the gutta-percha of cables; whether it is not possible that some of these are due to electric waves of high potential which have got into the core and punctured its dielectric at previously weak spots; whether, indeed, such faults are not found occasionally to develop in the wake of a storm?

I would also point out that the fact that a lightning switch is found damaged, or its wire perhaps fused by a flash, is no proof that it has entirely protected the cable from hostile influence. It shows that it has done the best it can; but since that best falls short of perfection, the damage to the protector, proving that there has been occasion for its activity, proves likewise that the

cable has been in a position of danger, has received some proportion of the damaging current, and in all probability has suffered some amount of deterioration. The voltage which plays about in the very feeblest form of statical discharge is so enormously greater than anything ever developed by ordinary voltaic batteries, that one cannot regard with equanimity the entrance of any portion of such electromotive forces into the delicate vitals of a cable. Remember that a millimetre spark means 3,000 volts.

To illustrate by experiment the assertion I have virtually made —that no conceivable form of single air gap, whether it be between knobs or points or plates or wires, or between wire and tube, or coil and cylinder, or any other possible device, can possibly afford complete and adequate protection—I take the following simple instances :—

Experiment No. 1.

Arrange a small air gap, as, for instance, between the knobs of a common "universal discharger;" connect the ends of a tangle or loop of thin covered wire, one on each side of the gap, and pass a Leyden jar discharge across it. The insulation of the thin wire is sparked through wherever two portions happen to come close enough together. [The wire actually employed had been the secondary of an old induction coil, and had been well soaked in paraffin.]

Experiment No 2.

Diminish the air gap until the knobs actually touch. The sparking at the crossings of the tangle are rather less bright and numerous than before, but they still frequently occur.

Experiment No. 3.

Instead of an air-gap, however short, use a foot or two of stout No. 0 copper wire or rod of highest conductivity, and shunt this with a thin wire tangle or coil. On passing a discharge along the rod, the crossings of the tangle sparkle as before, showing that the double insulation is still broken down.

These extremely simple observations establish the position I hold that no ordinary protector can switch the whole of a flash out of a coil; for a solid copper rod, no matter how thick, is unable to do it, although such a shunt as that would divert every appreciable vestige of signalling or other useful current. The fact is that to sudden discharges the impedance of a short copper rod may run as high as 100 ohms; and if the discharge current while it lasts is 100 ampères, which is a very moderate value, then we see at once that the E.M.F. needed to drive the current through the rod is 10,000 volts, and this is therefore for an instant the difference of potential between its ends. Such a difference of potential can leap three or four millimetres of air, and is amply sufficient to burst through the insulation of silk-covered wire several times over.

The particular mode adopted in these and such-like experiments for sending a Leyden jar discharge through the rod or across the air-gap is quite immaterial; any convenient plan serves, from simple hand discharging tongs upwards. But, once more, I may say that the handiest method of working is to use a couple of jars, to connect their internal coatings with the terminals of an electrical machine, the distance apart of whose terminals regulates the energy of the discharge employed; and to connect the outer coats of the jars to the two ends of the rod, or to the two rods of the universal discharger, or to whatever the flash is wanted to pass through. Instead of a wire tangle or loop, which only typifies the coil of an instrument, and whose only advantage is that one has no compunction in spoiling it, I next proceed to employ an actual galvanometer, and take it as representing anything requiring protection, whether it be telegraph instrument or cable or electric light installation of any kind. A galvanometer serves pretty well, because it indicates whether any disturbing current passes round it or not. Notice, however, that it only indicates properly when the discharge really goes round the coil. If it jumps across insulation, and, still more, if it jumps from terminal to terminal, the needle indicates less or nothing. There are, in fact, two things to be aimed at and considered separately in the protection of instruments :—

First: the current has to be prevented from passing round the coil, and thus disturbing the magnetism of the needle.

Second: it has to be prevented from jumping across from layer to layer, and so damaging the insulation.

Conduction protection and insulation protection: both must be attended to. To carry out both these protections completely is not easy; but I apprehend that the protection of the insulation from permanent damage is usually more important than the elimination of temporary disturbing currents which interfere with signalling and make the needle kick while they last.

The galvanometer I use is a simple reflecting instrument, of a pattern devised by Prof. Stuart at Cambridge some time ago. A copper iron junction momentarily touched with the finger demonstrates that it is in a sensitive condition, and could easily be made to furnish its effective constant were it worth while. Connecting its terminals to the outsides of the pair of Leyden jars whose knobs are attached to the machine, separating the machine terminals about the fiftieth of an inch, and turning slowly, we see an attempted steady deflection representing the charging current, interrupted by a series of reverse kicks which occur at every minute discharge; though the sparks of any discharge such as is safe to send through the instrument are too faint to be heard.

Experiment No. 4.

Now insert between the wires leading to the galvanometer a sort of lightning guard; a pair of plates mounted on a sliding arrangement, so that their distance can be varied (fig. 1). Directly the plates approach within sparking distance, the galvanometer is apparently protected, and its kicks cease, even though by extending the machine terminals further the energy of the discharges be increased.

Interpolated Experiment No. 5.

Although not immediately important, a little fact may here be noted. If the plates of the guard are pushed still nearer together, or lightly pinched together, so as to leave only a microscopic interval, and almost to obliterate the existence of a spark between them, the needle of the galvanometer again begins to kick at every discharge; but this time wildly and irregularly, and sometimes in the reverse direction. Occasionally these disturbances are very strong, and the spot of light disappears; only to be recovered by tapping the instrument. At the instant when these kicks occur, the plates are momentarily short-circuited, as may be proved by replacing the galvanometer by a Léclanche and electric bell. The bell is liable to ring at every discharge, and obviously for the same reason as the galvanometer kicks.

But whereas the bell only proves momentary conducting contact, the galvanometer proves this plus an electromotive force of occasionally uncertain direction and always uncertain magnitude. This E.M.F. would seem possibly to have something to do with the infinitesimal spark which temporarily connects the plates, and suggests an E.M,F. like the E.M.F. in an arc.*

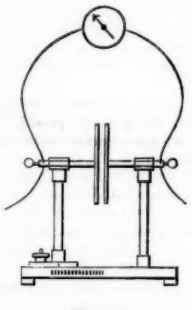


FIG. 1.

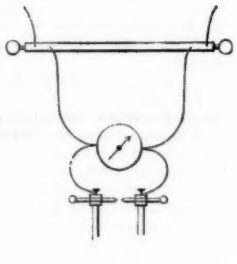


FIG. 2.

Returning now to Experiment 4, which illustrated the protection afforded to a galvanometer by a shunting air-gap, it is natural to ask how it can be reconciled with our previous observation, that protection by a single air-gap was impossible. But remember that complete protection involved two things, conduction protection and insulation protection; and the non-deflection of the needle merely shows that no important quantity of electricity now finds its way round the coil. But is the galvanometer therefore safe? By no means. Its insulation is in imminent danger, and if but moderately energetic flashes are employed we shall see sparks leaping across the coils or jumping from them to the metal work in a very pronounced manner.

Experiment No. 6.

As this is rather rough on the galvanometer, I prefer not to use strong flashes, but to show the existence of the tendency with smaller ones by arranging a safety valve or supplementary minute

* When I first came across this effect some weeks ago it was with tinfoil inserted between a pair of sparking terminals, and after the kick the tinfoil was often found fused on to one or other terminal. I therefore put it down to a thermal junction between tin and copper, caused and excited by the heat of the spark; and since it was a toss-up which side of the tinfoil adhered (being the side which made a just imperfect enough contact) the fluctuations of direction were easily accounted for; and by special trial this explanation was found to hold good. But then in this case after one kick the galvanometer was quiescent at subsequent discharges, until the tinfoil was distributed sufficiently to break the fused contact again.

The experiment described in the text differs, in that there are no two metals, the metal is not fusible, the infinitesimal spark occurs between a pair of similar brass plates, or knobs, and the short-circuiting is quite temporary. I surmised, therefore, that it might possibly be a phenomenon of greater interest than a mere thermo-electric one. But after the reading of the present paper, Professor Hughes informed me that he had come across the very same effect, and had satisfied himself that it was only a thermo-electric one. I now think it possible that he is correct, and that the junction is caused by a momentary heat pimple after the fashion of a Trevelyan rocker or Gore's circular railway. And though this plausible explanation deprives the observation of any theoretical interest, I do not blot it out of the text, but leave it as a record in order to save the time of future experimenters who may easily come across the same thing.

air-gap between the galvanometer terminals; said safety valve being either a couple of pins brought close together, or a chink cut across a narrow strip of tinfoil pasted on glass.

The high electromotive forces which are endangering the insulation, and very likely already jumping in invisible places, can now demonstrate their existence by leaping this chink; and, no matter how the lightning-guard plates are arranged, it is impossible to check the little sparks occurring at the safety valve at every flash. Bringing the plates into absolute contact lessens the brightness of these sparks, but does not stop them; neither does replacing the plates by a solid bar of metal, as in fig. 2.

But, directly the safety valve is employed to filter off and render manifest the residual effects left by a lightning-guard, the galvanometer needle begins to kick again whenever it acts; so that, singularly enough, whereas when no safety valve was employed the galvanometer appeared protected by the lightning switch, inasmuch as its needle is stationary, directly the safety valve is added and allowed to sparkle the needle kicks wildly with the very same flashes as before it ignored.

This behaviour appears mainly due to the same cause as produced the disturbance in the experiment interpolated above;* but it may be partly due to the weakening down of the flash by the safety valve so much that a residue of it is able to make its way round the coil, whereas it had previously been too strong, and preferred jumping across insulation in a manner ineffective for galvanometry. The possibility of the occasional truth of this latter explanation is by no means to be overlooked. It often happens that an unprotected galvanometer has its needle less strongly affected by sparks, say an eighth of an inch long, than by sparks the fiftieth of an inch long; but the reason obviously is that the more violent discharges are not really passing round the coil, but are taking all manner of short cuts.

Experiment No. 7.

Instead of employing a rigged-up model of a protector, for the purpose of calling attention to principles, an actual lightning-guard may, of course, be used, and its behaviour studied in detail. I take, as an excellent instance, a Saunders protector, so much employed in connection with submarine cables. Its essential part is a fine wire, through which the useful currents have to pass, surrounded by an earth tube with points protruding towards the thin wire, which is stretched by a spring along its axis. The idea is that the tube will relieve the wire of dangerously high potential, while the wire itself will fuse if dangerously strong currents try to pass along it. A supplementary device is a short-circuiting contact, whereby a spring puts the cable to earth directly the wire is fused, or in any other way broken. The diagram (fig. 3) sufficiently represents the instrument. A Jamieson protector is a neat arrangement, involving a fine wire as well as an air-gap; there is also some wire coiled on a metal cylinder, but the metal deprives it of all appreciable self-induction.

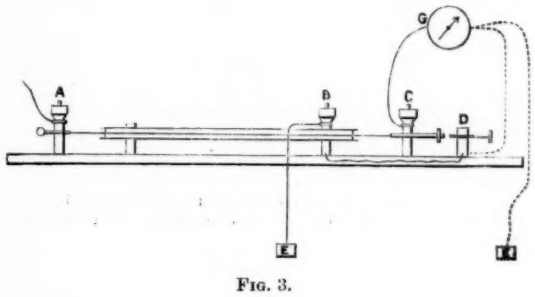


FIG. 3.

If I now send very small discharges down the line wire towards a galvanometer protected by this Saunders guard, they will, if small enough, escape it and pass through the galvanometer, either exciting its safety valve or disturbing its needle, or both. But if stronger flashes are sent, the protector begins to act, sparks are seen between fine wire and surrounding tube, and the galvanometer disturbances diminish as already explained; but those at the safety valve never wholly ceases. One is not to suppose that the bigger the flash the less the effect; that would be a very desirable but somewhat impossible conjuncture. The smallest effect is got with the weakest flash, which is just sufficient to spark to the protecting tube. Anything stronger or anything not greatly weaker than this gives larger effects.

The fine-wire part of this guard is a good feature, and one that may be advantageously introduced into any protector, on the principle of a safety fuse or cut-cut, to eliminate steady or slowly varying currents of two great strength. But the short-circuiting of the protected terminal to earth by the terminal, D, as soon as the wire is destroyed, is perhaps not an unmixed good, for a subsequent earth-seeking disturbance has then two paths between which it may divide—if the connections are made as in fig. 3—one along the intended earth wire, and the other through the instrument intended to be protected.

True, this latter is a much longer route, but not so infinitely longer that it need convey none; especially if a few short cuts across insulation can be taken.

We see, at any rate, how important it is to make the earth lead as short and direct as possible, and how it is better to connect the thing to be protected to the two binding screws, C and D, of the instrument as indicated by the dotted line rather than to make an independent earth.* If, for instance, a cable be joined inside to C, outside to B or D, the spring short circuiting is all good, the only objection being that however prompt the spring may be there is ample time for damage before the contact can be made.

The statement concerning the importance of a short and direct earth also applies to the desirable mode of connecting up lightning guards in general. They should always be inserted direct into the line circuit between line and earth, never be simply led up to by side wires.

Thus, of the three modes of connecting a plate or other lightning protector to a telegraph instrument, fig. 4 is an altogether bad mode; fig. 5 is but little better; fig. 6 is the same thing, or even worse; while fig. 7 is a thoroughly good way. As I have said so often, even this is not perfection, but it is quite the best that can be done with a single air gap of whatever kind.

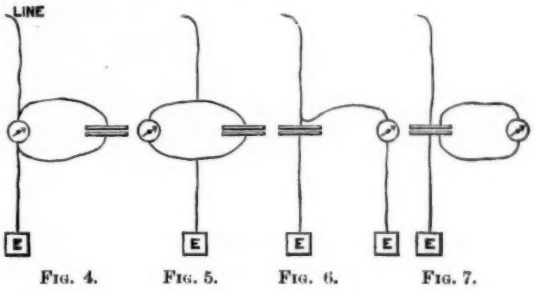


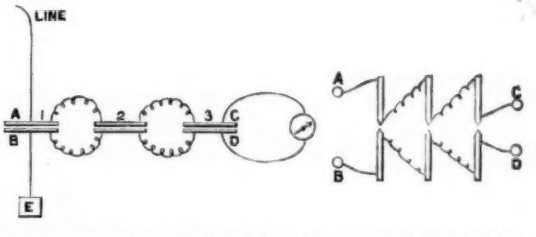
FIG. 4. FIG. 5. FIG. 6. FIG. 7.

Throw the leads into the protected circuit; let nothing interfere with direct connection of lightning switch to line and earth respectively, and don't use an independent earth for your instrument's earth terminal. The time taken for a disturbance to travel even a foot of copper wire is by no means to be despised, notwithstanding that it travels with the speed of light; and the impedance of every inch tells.

I will now describe the principle of my own lightning guard, and will then connect it to the circuit in place of Saunders's, and show that it affords practically complete protection for both small and big flashes.

The principle is one very easy to understand. It is merely to take the overflow from one protector and give it the chance of another, then to take the overflow from this and offer it another air gap, and so on till nothing is left; at the same time diminishing the overflow from each protector as much as possible by the use of self-induction coils, which impede the violently varying or alternating rushes by their electro-magnetic inertia.

Thus, for instance, using a series of plate protectors, we may couple them up as shown in fig. 8.



A, B, are the exposed, or line and earth, terminals; C, D, are the protected terminals. Corresponding terminals are lettered the same in all the diagrams.

FIG. 8. FIG. 9.

Only a small fraction of a sudden shock will escape No. 1; say a thousandth part, since it is offered the inertia or impedance of the coils as the only alternative. A thousandth of this again may escape No. 2; and a thousandth of this, or a thousand-millioneth of the whole, is all that is left for the galvanometer. By adding to the series, if it were necessary, it is manifest that a disturbance may be diluted down to any desired extent, with the rapidity of a geometrical progression.

I do not indeed propose to use plates commonly; simply because they are more bulky than necessary, not so easy to adjust, and not so open to inspection as knobs or points. More-

* I do not feel quite certain of the sufficiency of Prof. Hughes's thermo-electric explanation.

* The dotted line connection in fig. 3 is the most favourable possible, and it was the one used at the meeting. It is far better than an independent earth for the galvanometer terminal.

over, the first or exposed pair of such a series is likely to be damaged by lightning; and when damaged, it may be permanently short-circuited or otherwise inconveniently altered in a troublesome and invisible manner. I prefer that the terminals of the first air-gap shall be easy to examine, easy to remove, and cheap to replace.

The last air-gap of a series I prefer to be very finely adjustable indeed, with screw adjustment; and all of them should be open to inspection, so as to avoid accidental contact on the one hand, or undue air space on the other. I therefore propose simple brass rods for the exposed air-gap, adjusted just far enough apart to exclude that disturbing thermo-electric or other effect caused by a spark occurring between their surfaces. All rods must be short, so that heat expansion may not short-circuit them. The theoretically best place to tap off the useful current is from near the tips in contact, so as to tap off a minimum of impedance with a maximum, as thus, Fig. 9:—

Making a rough model of such an arrangement, with coils of a few yards of stout gutta-percha-covered wire, wound on cotton reels, I tested it by inserting a scrap of extremely fine wire between D and C, by holding them with wet fingers, and so on; but was unable to fuse the finest wire, or to feel any disturbance, although great flashes were going to A and B, and the early air-gaps were sparking properly. Large condensers, composed of great piles of window glass—the same condensers as I had used for obtaining very slow oscillation—and the discharge of which had a powerful deflagrating effect, were used in this experiment, as well as more moderate capacities, such as a Leyden jar battery, and single jars; but still no effect at the protected terminals. This was the stage I had reached when I read my last paper—the one on lightning conductors, &c., before this Institution.

(To be concluded.)

Royal Society.

"On the Heating Effects of Electric currents. No. IV." By WILLIAM HENRY PREECE, F.R.S. Received April 22nd, 1890.

The effects of the heat developed in conductors when electric currents are transmitted through them have been the subject of constant investigation on my part since 1878. In 1880 I found that the rapidity with which small bare wires acquired higher temperatures and lost them in air was so great that it was possible to reproduce sound and speech by means of the thermo-telephone ("Roy. Soc. Proc.," No. 204, 1880).

I determined subsequently ("Roy. Soc. Proc.," No. 231, 1884) the current that raised the temperature of small conductors in air to the fusing point, and proved experimentally that, while bare cylindrical wires of very small diameter did not follow the $d^{\frac{3}{2}}$ law, this law became rigid for all diameters above 1 mm.

Papers "Roy. Soc. Proc.," November 24th, 1887, and March 15th, 1888, dealt principally with the fusing points, and the following table, to which I have added silver, gives the fusing constants for all the metals in general use when bare and exposed in still air. The numbers indicate the current in ampères which is required to fuse a cylindrical conductor of a diameter of 1 cm. of the material named.

	Fusing constant. (a).	Fusing temperature. C°.
Copper	2530	1054
Silver*	1900	954
Aluminium	1873	650
German silver	1292	1200
Platinum	1277	1775
Platinoid	1173	1300
Iron	777·4	1600
Tin	405·5	226
Lead	340·6	335
Alloy (lead 2 parts, tin 1 part)	325·5	180

* G. Roux, *L'Electricien*, December 14th, 1889.

I have added the temperature of fusion to each of these metals, and the table means that if we take, for example, a uniform copper wire of 1 cm. diameter, a current of 2,350 ampères will raise it to 1,054° C., and therefore fuse it; and if we take any similar conductor of copper, but of different diameter (d), the fusing current (c) is

$$c = 2530\, d^{\frac{3}{2}}.$$

The fusing current of any other material is obtained from the equation

$$c = a\, d^{\frac{3}{2}}$$

It seemed natural that these constants, marking such a distinct and well-defined fiducial point, should also enable us to obtain the currents that would raise the wire to any other temperature.

A constant current traversing a cylindrical metallic conductor does work (w) upon that conductor to an amount which is measured per second by the product of the electromotive force (E) at the ends of the conductor and the current (C), or

$$W = E\,C.$$

This work appears as heat. The temperature of the conductor is raised. When the temperature of the wire becomes constant the expenditure of energy in the wire, and its dissipation by radiation and convection from the surface of the wire, must be equal and constant also. Hence the temperature of the conductor when constant becomes a measure of the work done per second, and therefore a measure of the constant current flowing. The rate of loss of heat per degree per unit area of any surface is its emissivity (e). The value of e depends upon the character of the surface, that is, whether it is polished or rough, clean or dirty, bright or black, metallic or oxidised, painted or coated with some preservative or insulating medium. For the present we will consider an unprotected surface comparable with the surface when at white heat, and we will call that surface *normal*. Let a current be applied to a given conductor, exposed in still air at atmospheric perssure, until it assumes any constant temperature (T), the surrounding objects being at a lower temperature (T_1); then the total heat (w) which will be emitted per second by the whole surface (S) of the wire to the surrounding objects will be

$$W = e\,S\,(T - T_1).$$

Hence
$$E\,C = e\,S\,(T - T_1) \qquad (1)$$

or
$$e = \frac{E\,C}{S\,\theta},$$

if we put θ for $T - T_1$, the excess of temperature acquired by the wire.

Hence we can determine e for any conductor at any temperature by measuring E C and θ.

Putting $E = C\,R$, $S = l\,\pi\,d$, and $R = 4\,\rho\,l/\pi\,d^2$ (ρ being the specific resistance in C.G.S. units, l the length, and d the diameter in centimetres), (1) becomes

$$4\,C^2\,\rho = e\,\pi^2\,d^3\,\theta,$$

and
$$\theta = \frac{4\,C^2\,\rho}{e\,\pi^2\,d^3} \qquad (2)$$

Now, if ρ and e vary together in the same proportion in terms of θ, then $\theta = \kappa\,C^2$ for any particular wire. That ρ and e do vary together in the same proportion is entirely in accordance with measurement and experiment; and it is interesting to note that it is also in accordance with the researches of Mr. J. T. Bottomley on thermo-radiation (*Phil. Trans.* vol. 178 (1887), A, pp. 429—450). Thus, if we take the table given on p. 443 of that paper, and work out the variation in resistance of a platinum wire (which variation is the same as for copper) by the usual formula,

$$R_t = R_0\,(1{\cdot}0038)^{\theta},$$

we get the values shown in the fourth colnmn:—

Bottomley's researches.				R_t calculated from the formula $R_t = 14{\cdot}5\,(1{\cdot}0038)^{\theta}$.
θ.	$C^2/R\,J\,s$.		e.	
65°	9·45 × 10⁻⁴		14·5 × 10⁻⁶	14·5
110	20·53	,,	18·7 ,,	17·2
232	74·7	,,	32·2 ,,	27·3
383	236	,,	61·6 ,,	48·4
740	1,468	,,	198 ,,	187·6
900	3,218	,,	358 ,,	344·2

If we determine c for any temperature, then, since $\theta = \kappa\,C^2$, the current c′ producing any other temperature θ' is obtained by means of the equation

$$c' = c\,\sqrt{\frac{\theta'}{\theta}}.$$

Now, for copper of 1 cm. diameter c = 2,530 for 1,054°. Thus, if we want to find the current that will raise such a conductor to 13°, we have

$$c' = 2{,}530\,\sqrt{\frac{13}{1{,}044}} = 281 \text{ ampères},$$

if the surface be equivalent to the assumed normal surface.

Now, since we are dealing with metallic surfaces only, and the normal surface has been defined to be that comparable with the surface when at a white heat, it remains for us to determine the coefficient which shall convert this normal surface emissivity to that of the surface of ordinary wires at low temperatures. This I have done for copper, and the results have been amply confirmed by by Mr. Kennelly, in Mr. Edison's loboratory at Orange, N.J., U.S.A.*

Taking the normal surface as unity, then

	Surface coefficient.
Bright and polished copper	0·5
Copper, dirty, oxidised, or blacked with shellac varnish	0·6
Copper, well coated with lampblack	1·0

Taking a wire 1 cm. in diameter and calculating from $c' = 0{\cdot}5\,c\,\sqrt{\frac{\theta'}{\theta}}$ for bright wire and $0{\cdot}6\,c\,\sqrt{\frac{\theta'}{\theta}}$ for black wire, we get a concordance which is very satisfactory.

* A. E Kennelly, "On the Heating of Conductors by Electric Currents." (Abstract of report read before the Edison Convention at Niagara Falls, August, 1889; *Electrical World*, November 23rd, November 30th, December 7th, and December 14th, 1889.)

5°.				10°.				20°.				40°.				80°.			
Bright.		Black.		Bright.		Black.		Bright.		Black.		Bright.		Black.		Bright.		Black.	
P	K	P	K	P	K	P	K	P	K	P	K	P	K	P	K	P	K	P	K
87	85	104	104	123·2	120	148	147	168	169	201	207	243	236	291	290	350	329	420	410

N.B.—P means calculated from the formula $c' = 1{,}265\sqrt{\frac{\theta'}{\theta}}$, and K means the figures obtained by Mr. Kennelly.

Now, the current (c) producing 1,054 (θ) in a bare bright copper cylinder of 1 cm. diameter is 0·5 × 2,530 ampères, and that which would produce a temperature of 10° C. is

$$0{\cdot}5 \times 2{,}530\sqrt{\frac{10}{1{,}054}} = 123{\cdot}2 \text{ ampères.}$$

Using both alternating and continuous currents, it was found that, in a copper wire with $d = 0{\cdot}6956$, θ was 50°·3. Now the current (c'), that will raise a wire 1 cm. in diameter 50°·3 in temperature is

$$c' = 2{,}530\sqrt{\frac{50{\cdot}3}{1{,}054}} = 552{\cdot}7 \text{ ampères.}$$

But the current that will raise a wire of a diameter of 0·6956 cm. through the same temperature is

$$(c \times d^{\frac{3}{2}}) = 552{\cdot}7 \times {\cdot}6{,}956^{\frac{3}{2}} = 320{\cdot}6 \text{ ampères;}$$

or, if the wire be dirty,

$$320{\cdot}6 \times {\cdot}6 = 192{\cdot}4 \text{ ampères.}$$

The current actually was in each case 198 ampères.

A copper conductor, bare and dirty, 20 feet long and 0·415 in. in diameter, was stretched across a room where the air was still, and various continuous currents were transmitted through it. The results are tabulated and the observed and calculated currents given.

Time.	Increase of temperature of wire C.	Current in ampères. Observed.	Current in ampères. Calculated. $c' = 0{\cdot}6\ c\sqrt{\frac{\theta'}{\theta}}\ d^{\frac{3}{2}}$	Remarks.
10·45		454		
11·15	86°	454	467·7	
12·0	80	450	451	
3·30	79	445	448	
3·45	78	440	445	
4·30	73	429	431	
Current stopped; wire cooled. Current put on again at 5.30.				
6·0	38	290	310	

Thus, if we know the current producing any fixed temperature in any cylindrical conductor, we can readily calculate the current required for any other temperature.

Physical Society.—April 18th, 1890.

Prof. W. E. AYRTON, F.R.S., President, in the chair.

Mr. W. B. Croft was elected a member of the Society.

Prof. RUCKER described the results of "Some Recent Magnetic Work" undertaken by himself and Prof. Thorpe in connection with their magnetic survey of the United Kingdom.

In a paper read before the Royal Society last year they have shown that the United Kingdom can be divided into seven or eight distinct districts, in each of which a source of disturbance seems to exist. The probable cause of these disturbances the authors believe to be the presence of "magnetic rocks." If this be true, an intimate connection should exist between the magnetic elements of a district and its geological structure. If a magnetic mass be supposed to exist below the surface, then one would expect the vertical force to be greatest above that mass, whilst the horizontal disturbances would tend towards the mass and would differ in direction on its opposite sides. With a view to testing more fully than heretofore the magnetic constitution of the districts above referred to, the work (the results of which Prof. Rücker now described) was undertaken.

Two test districts were selected in which numerous observations were taken; one of these is situated on the west coast of Scotland, and the other embraces parts of Lincolnshire and Yorkshire. The first of these districts was chosen for two reasons: First, because it is very disturbed and, owing to the vast masses of basalt, would be a specially difficult one; and secondly, because it is near the borders of their survey and is thus particularly open to suspicion that the calculated values of the elements may be inaccurate.

By the aid of magnetic maps Prof. Rücker showed that a centre of disturbance exists to the west of Iona and south of Barra. Both the vertical force and the horizontal disturbances indicate the same position and hence favour the hypothesis.

In the Lincolnshire and Yorkshire district, extending from the Wash to Appleby, there is a region in which the horizontal disturbances along the east side tend towards the west, whilst along the west side they are on the whole directed easterly. This points to a ridge of magnetic material along the middle of the region, and from numerous observations the approximate position of the ridge line has been determined over a length of 150 miles. In Lincolnshire the ridge follows closely the line of Wolds, whilst at the Kettlewell end it is directed towards the Cumberland Lake District. Places of maximum vertical force occur near Market Weighton and Harrogate.

The observers were directed to Market Weighton by Prof. Judd, as being situated where the liassic strata thins out. Harrogate stands on the summit of an anticlinal. The fact that such places of maximum vertical force exist where according to hypothesis they would be expected, tends to confirm the supposition, and thus to demonstrate that a very close connection exists between the magnetic elements and the geological structure of a country. This is further confirmed by the observation that in Lincolnshire the line of disturbance follows closely the line of the Wolds, and that from Market Weighton it passes across the plain of York to the millstone grit and limestone which are the oldest rocks in the neighbourhood.

Mr. WHIPPLE said he had listened with very great pleasure to the most interesting details and results given by Prof. Rücker. Never to his knowledge had a magnetic survey been conducted with such minuteness and accuracy. The older surveys related chiefly to declination, whilst the determinations of intensity were made in a very primitive way. He looked forward with great interest for other important results which he felt sure would follow from the admirable survey of Profs. Rücker and Thorpe.

A most cordial vote of thanks was accorded to Prof. Rücker for his most interesting and valuable communication.

Mr. T. H. BLAKESLEY (hon. secretary) read a paper on "A Theory of Permanent Magnetism," by M. OSMOND. The author stated that iron exists in two distinct physical states, one soft, or "α iron," and the other hard, or "β iron." The β variety is non-magnetic and is formed during heating, hardening, or by electrolysis, whilst the soft, or α modification, is produced by long annealing.

In a piece of steel the author considers the β molecules to form a rigid framework in which the α molecules become interlocked under the influence of magnetising force, and on the degree of interlocking the permanent magnetism depends. By a graphical method it is shown that the permanent magnetism should be a maximum when the two varieties are present in equal quantities. If the proportions of carbon and manganese in the steel are considerable, then nearly all the iron is of the β variety and the steel is nearly non-magnetic.

In hardening a piece of ordinary steel the surface layers, being cooled most rapidly, contain more β molecules than the interior; hence for a certain degree of hardness (when the outer layers have more α molecules than β ones) a laminated magnet will be a better permanent magnet than a solid one, but for a much greater degree of hardness the reverse may be the case.

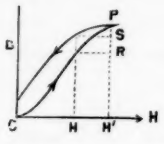
Mr. SWINBURNE asked if the theory would account for the increase of induction which occurs when the circuit of a permanent magnet is closed; most theories founded on the orientation of particles by the magnetising force seemed defective in this respect. Some time ago he had suggested that the permeability of iron should be tested by first magnetising it one way, and then at right angles to the first direction; recently he had been informed that no increase of permeability was observed when the experiment was performed.

Prof. PERRY said he had subjected iron to magnetisation in one direction and found the permeability for small forces in a direction at right angles much smaller than he had anticipated; the first magnetising force was kept constant when the small perpendicular one was applied.

Mr. SWINBURNE thought that for such small perpendicular forces the permeability should be nearly infinite. He also said there seemed a sort of angular hysteresis in iron, for if a loose running armature was turned slowly round by hand it would come back 2° or 3° when left free.

The PRESIDENT remarked that as far as he could see M. Osmond's theory does not account for the great influence which a small percentage of tungsten has on the magnetic property of steel, and all theories which failed in this particular must necessarily be imperfect.

Mr. BLAKESLEY pointed out that the ordinary hysteresis curves showed that a small superimposed magnetising force, in a direction different from the primary one, produced only a small change



in the induction, and hence would give a small permeability. For example, the increment H H' (see fig.) causes an increase R P in the induction, whilst an equal decrement H' H produces only a change P S.

MAY 2ND, 1890.

Prof. W. E. AYRTON, President, in the Chair.

Mr. C. V. BOYS made two communications: 1st, "On Photographs of Rapidly Moving Objects," and, 2nd, "On the Oscillating Electric Spark." A collection of apparatus by which he had been able to photograph drops of water in their various stages of formation, was exhibited. It consisted of a lantern and lenses by which a trough in which the drops were formed could be strongly illuminated, combined with a camera and revolving disc with one perforation. By this means, exposures of about $\frac{1}{600}$th of a second could be made about 20 times a second. The slide of the camera was about three feet long, and could be moved across the field by hand so as to take the consecutive impressions on different parts of the plate. The resulting photographs show with remarkable clearness the formation, breaking away, the oscillations of the drops, and their rebounding in the liquid into which they fall. By cutting the photographs into strips, each strip representing a single exposure, and mounting them on a disc, Mr. Boys had arranged a kind of thaumatrope which represented the phenomena in a very realistic manner. He also exhibited photographs of small water fountains broken up into drops by musical sounds, which he had taken by the electric spark without the aid of lenses. The shadows of the drops were sharply defined even when magnified considerably, and the various stages of transition from the liquid column to the detached particles were well shown. Finding it possible to obtain such good results from a simple spark, it occurred to him that he might get a succession of photographs from the intermittent light of an oscillating spark, and in this he was fairly successful.

An apparatus devised to show the oscillatory character of a discharge was next exhibited in operation. It consisted of a disc carrying six lenses arranged in two sets of three. The members of each set were at different distances from the axis, so that the images of the spark on the screen do not coincide. The disc can be revolved at a high speed, and the successive sparks are seen as bright patches on the screen. By this apparatus a single discharge can be examined, whereas with Dr. Lodge's apparatus it is desirable to have a fairly rapid succession of sparks. Photographs of an oscillatory discharge taken with the apparatus were exhibited, and these show that the duration of the illumination is a considerable fraction of a complete period.

Lord RAYLEIGH said he was greatly interested by Mr. Boys's apparatus. He (Lord Rayleigh) had photographed water fountains both when broken up, and when made to coalesce under electrical influence, but it had never occurred to him that it would be possible to get enough light or sufficient sharpness from a single spark. Mr. Boys's success he believed to be owing to the fact of his using no lenses, which would absorb the ultra-violet rays. He also thought the method might be developed so as to give shaded pictures instead of mere representations in black and white.

Mr. GREGORY asked Mr. Boys if he had tried to get greater potentials for his oscillatory discharges by using Dr. Lodge's "impulsive rush" arrangement.

Mr. TROTTER enquired whether the single sparks used to photograph the water fountains were as large as those required to show oscillations.

Mr. BOYS said he had not tried Dr. Lodge's "impulsive rush" arrangement because of the enormous capacity of the condensers required. The sparks used to photograph the broken up fountain was very small, being only about ¼ inch long and from a few jars.

Prof. PERRY asked Lord Rayleigh whether it would be possible to compare the shapes of the water drops shown in the photographs with the shapes of the liquid surfaces of revolution given by Sir W. Thomson at the Royal Institution some years ago, or whether the changes of shape were too rapid to permit of the surface tension being all important.

Mr. BOYS thought the motions of the drops would be too rapid, and that inertia would play an important part.

Lord RAYLEIGH pointed out that by forming a drop slow enough, the effect of inertia might be made negligible until such time as the unstable state was reached; after that, however, inertia must have considerable influence on the shape.

CORRESPONDENCE.

Lightning Arresters.

I am very sorry to see the communication which appears in your last issue under the above heading. As it is an unsigned communication I should have considered it not deserving of any attention were it not for the editorial note "that the work done by Varley has evidently been overlooked by our correspondent."

I, myself, have made it a rule never to write anything for publication without signing it, for to do otherwise, in my own case, I have always felt would be mean and cowardly. Of course I recognise there is no rule without an exception, but in nine cases out of ten communications, such as the one I am commenting upon, are simply cowardly stabs in the back delivered by some one having an axe of his own which would be in danger of becoming tarnished if not carefully covered up. A French proverb says "*Cherchez la femme*," and I would say in respect to your correspondent's communication "*Cherchez l'intérêt.*"

In a sense it is amusing how certain writers have made the name of Varley conspicuous by its very absence, but perhaps after all it is making too great a demand upon authorities, whose disinterestedness and largeness of soul is above all suspicion, to expect them to remember a name, the initial letter of which is buried so deeply down in the alphabet, if they are only able to remember names as far down as the letter P, or thereabouts, it is possibly as much as can be fairly expected in these days of high pressure.

Your correspondent very laudably desires to honour the discoverer rather than the adapter, and therefore I presume he considers the Varleys to have been such mere adapters that their name is not worthy of mention alongside such *distinguished* discoverers and *eminent* electricians as the late Sir Charles Bright, Mr. Preece, and those others whose names are referred to by your correspondent.

All the applications of electricity to the service of man, with the one exception, viz., lightning rods, may be said to have been introduced during the last fifty years, and if a *true* history of the electrical progress made during the period named *be ever* written, then I venture to say (your correspondent notwithstanding) that the name of Varley will be assigned a more or less honourable position.

The late C. F. Varley introduced vacuum lightning protectors as far back as 1848, which, if my memory serves me rightly, was a good many years before Sir Charles Bright designed a vacuum protector, which your correspondent describes as a very ingenious one, but which outwardly, at all events, had a very strong family likeness to Varley's first form of vacuum protector.

I have no hesitation whatever in saying that the most original of the lightning protectors was my "Lightning Bridge." It acts on an altogether different principle to *any* other lightning protector, and was an absolutely new principle at the time of its introduction. The principle of its action is precisely similar to that of a carbon microphone which it preceded by a great many years, but, considered as a microphone, its range is practically infinitely greater. To a working current it opposes a resistance of say 70,000 ohms, whereas a lightning discharge reduces its resistance temporarily down to about 6 ohms. Its construction was due to an original observation made by myself when a heavy lightning discharge struck the suspended wire of a Morse telegraph circuit passing to earth through the apparatus and doing considerable destruction. What I observed demonstrated to me that a powerful current had passed through the apparatus which occupied a sensible interval of time, and I attributed it to the "extra current" developed after the discharge during the period occupied by the telegraph wire in passing from the magnetically polarised to the normal unmagnetic condition. The lightning discharge to which I have

referred occurred in Turkey in 1856, and careful study led me to lay down conditions, which it seemed to me, a perfect lightning protector should fulfil. Ten years elapsed, however, before I was able to reduce theory to practice, and my bridge was the result of a long series of experiments carried out from time to time during the period 1856 to 1866. The scientific principles on which its construction was based were fully described at the British Association meeting of 1870, and at a time when considerably over a thousand of them were doing duty, and a fair proportion of them had been working for over four years.

In previous letters published in the ELECTRICAL REVIEW the unfair treatment which my bridges received at the hands of the Postal Department have been referred to. A paper read in 1872 at the Electrical Engineers by Mr. Preece, condemned my bridges because they conformed to a disciplinary regulation *insisted* upon by the engineering department, and the speech I made in self-defence during the discussion, was suppressed entirely from the published proceedings of the society, presumably at the instance of the Postal Telegraph Department.

Some years latter a second paper was read by Mr. Preece at one of the meetings of the British Association on lightning protectors, the burden of his song being the survival of the fittest, but acting on similar lines to that adopted by your correspondent, whose communication has drawn forth this letter, the work done by Varley in the field of lightning research was entirely overlooked, and my bridges were not mentioned at all, although the Postal Department had then some thousands of them fitted to their instruments.

In August, 1882, a letter appeared in the ELECTRICAL REVIEW from Mr. Haines, the telegraph engineer of the Bristol and Exeter Railway, in which he gave his experience of 110 of my bridges, the greater percentage of which (73) were fitted in 1867 and the remainder (37) in 1872. All these bridges were doing duty last year, and I have no doubt they are doing duty at the present moment, discharges have been safely conducted across by them, and there has not been a single case of any of the protected instruments being damaged by lightning since my bridges were fitted, viz., 73 of them more than 24 years ago, and 37 of them 18 years back.

There is an old proverb "Hens come home to roost." If I discern the signs of the times aright, those of us who have the good fortune to remain in the flesh a few years longer, may live to see more than one hen come home.

S. Alfred Varley.

May 10th, 1890.

[The communication which has once again brought Mr. Varley's name into our correspondence columns, was written by a gentleman who has, we are sure, no desire to ignore the work done by himself and his late brother. He is not interested in one inventor more than another, and is not even a professor.—EDS. ELEC. REV.]

Electric Tramway Systems.

In your issue of May 9th you publish a description of an electric tramway system called the Waller-Manville, for which several features are claimed as new. I beg to point out to you that this system of collecting from a flexible conductor resting on hooks fixed to fluid insulators is by no means new, having been patented by me in 1887, and on comparing the description in your journal with my specification (Improvements in Electrical Tramways and Railways, No. 14,029, October, 1887), it will be seen that, except for a slight difference in shape of one or two parts, the two systems are identical.

The first person to employ fluid, or, indeed, any form of insulator that would give a high insulation in an electric tramway system was Mr. Volk, of the Brighton Electric Railway, and in his specification, No. 9,388, August, 1885, he describes a tramway system, the conductor in which is insulated with fluid insulators, and a removable lid provided to allow ready access to them for cleaning and repairs.

Mr. Volk, however, *fixed* his conductor to the insulators, and knowing the difficulty experienced in getting insulators to stand the strain without breaking when the conductor is rigidly fixed to them, the idea occurred to me to use a flexible conductor merely resting on hooks supported by insulators, the collecting arm being so fixed as to lift the conductor off each hook as it passes. This is the system described in my specification mentioned above, and, it will be seen, is also that of the Waller-Manville. Once a system is shown, any mechanic can work out fifty different forms of it.

The advantages mentioned at the end of your description of the Waller-Manville system are substantially those I have always claimed for mine, and I quote below one or two paragraphs from my specification which will show this :—

"Among the advantages consequent upon my invention may be mentioned the following: High insulation of the conductors, and the avoidance of all trouble caused by the breaking of the insulators from the jar of the collecting arm and the expansion of the conductor by heat."

"Hitherto the electrical conductors, in direct system electric tramways, have been rigidly fixed to the insulators or insulating material, so that when the collecting arm is passing each insulator the mechanical strain thrown on them by the jarring and pressure of the collector is very great, frequently causing them to break. It will be seen, however, on referring to the figure, that in this system the moment the collecting arm is passing an insulator all strain, both mechanical and electrical, is entirely removed from it."

"In order to prevent the collecting arm moving down lower from its proper height and so causing the roller to catch the supporting hooks, the collecting arm is fixed to the axle or frame of the car, and not to the body or other part of the vehicle that is usually supported on springs."

"By referring to any of the drawings it will be seen that the lids (*o*) in the insulator channel can be readily taken up and the insulators removed for cleaning or repairs without interfering with the traffic."

"A new conductor can readily be relaid through the slot."

No mention is made in the Waller-Manville system of any provision for turn-outs or junctions, whereas this is fully described in my specification.

I enclose a copy of my specification, in which you will find illustrations of the system.

F. C. Allsop.

May 12th, 1890.

[We would recommend those of our readers who are interested in the evolution of the conduit systems of electric tramways to procure Mr. Allsop's specification. We think that many patents are applied for and, in the English Patent Office, unfortunately granted, without due consideration of the previous work of others. —EDS. ELEC. REV.]

Electrical Club.

Your last week's issue contained a communication which had been addressed to you on trade amenities; and although I can hardly consider that all its opinions meet your approbation, your publication of it in some way concedes one point, and that is the independence of your correspondence columns. I will, with your kind permission, take advantage of this to say that I cannot for the life of me see what all the fuss of this Jeremiad is about, unless it be a tag whereon to hang the conclusion, which, by the way, has mighty little relevancy to what goes before.

I may be a mole, burrowing in the dark, going my own little way without troubling myself much about

what goes on about me; but I was not aware until last Friday, and do not know that I am now, of any burning question of who's who in our trade, and if, as the writer admits, no one is anything in particular, I cannot see what more is to be said thereon. I do not, however, object to his fighting his phantom in your pages if it amuses him, especially as the venting of his spleen seems to have done him good and enabled him to see things in a happier spirit towards the end.

The question of an electrical club, which was raised by yourselves a few weeks ago, and to which he alludes, is one of great interest to us all; and I am glad to be able to shake hands with your correspondent on this common ground. What, however, he fails to see, or seeing does not point out, is that a number of disconnected particles cannot vote themselves, by acclamation or otherwise, a club without someone to put the resolution. The sheep are in need of a shepherd to lead them into the suggested pleasant pastures. If someone would intimate through the various electrical papers that in a certain place at a certain time, a meeting would be held to discuss the matter, at which, say, everybody included in the "Electricians' Directory" would be welcome, a start might be made.

I am persuaded that the proposition to found such a club would meet with a cordial response from very many who would be pleased to make the acquaintance of their brother workers, and to have a place where they could meet in a less formal manner than during busy business hours those who they already know and might wish to see. It might be arranged that there should be 'change every day except Saturday at, say, 6.30 for half an hour, but that is a detail which I must beg the future committee's pardon for trespassing on. I am not of sufficient importance to plunge into the gulf myself, but being behind cry "forward" to those in front.

Trusting you will excuse the lengthiness of this letter, I enclose my card and beg to express my willingness to "make one."

Clubable.

Mr. Higgins's Institute Paper.

I wish to make a few remarks on Mr. Robertson's letter of last week. He has evidently misunderstood my paper.

By omitting a part of a paragraph he makes it appear that I claim to have discovered something which has "been long known to lamp-makers and used as a rough test of the state of exhaustion."

I said, after the portion quoted, that not having seen any mention of the property in question, I did not know whether my results agreed with those obtained by others, meaning, of course, numerical results which would show the extent to which lamps were affected.

The variable properties of air in this respect were known before the invention of incandescent lamps, and are in some works stated wrongly.

The novelty in my method is that it affords a means of testing which can replace the "rough test" mentioned, and enable manufacturers to test the condition of lamps by an instrument much more sensitive than the bare hand.

Testing by means of sparks from an induction coil is a very imperfect and destructive method. A spark will only pass through a hole in ordinary glass, either one already existing, or one made, or enlarged by the spark itself, the effect being to cause steady deterioration of the vacuum in a lamp so treated.

My statement that lamps with a perfect vacuum attain and lose their incandescence slowly, while others with a less perfect vacuum behave differently, was based on my own observations; and if there are exceptions to this rule, then the property which air possesses of conducting heat more readily as its density increases must be in some cases suspended, as, for example, in the case of the carbon of high specific resistance mentioned in the concluding lines of Mr. Robertson's letter, which will increase in incandescence and as suddenly lose it in a medium in which another carbon performs both operations slowly.

The sudden loss can only be caused by the heat being more rapidly removed than from the other filament, and both being in the same medium makes this difference somewhat difficult to account for.

Mr. Robertson states that the differences in the state of exhaustion between two carefully made lamps are far within the $\frac{1}{10}$th inch which I give. I purposely gave only the extremes of the scale; and as the difference between a highest possible and $\frac{1}{10}$th inch vacuum is 215 divisions, it is evident the thermoscope would indicate the intermediate state with a little more accuracy than is possible in testing with the bare hand, and without waiting for the bulb to become heated by convection.

F. Higgins

The Mutual Telephone Company.

I have read with interest your leader, entitled "The Beginning of the End," in this week's issue of your REVIEW. Without discussing several points of interest therein, I would confine myself to the statement, "that there are no patents other than Bell's which cannot be dispensed with."

This is Mr. Mann's statement, and from my own experience, as a manufacturer of a membrane telephone, I am convinced his assertion is absolutely correct.

Let the Mutual Telephone Company only appreciate the vital importance of teaching their customers to use the membrane or Bell Telephone properly (the speech from either of these being "much of a muchness"), and they will have the most successful telephone system yet started.

What teaching? Why that most important point, so little heeded, that in speaking to a telephone, which works by varying the strength of the current, it is absolutely necessary for *good effects*, that the mouth be held close to, in fact, better touching, the mouthpiece of the telephone. Let the mouth be held only two inches away, and the difference is like that between a faint whisper, and a loud voice. When the above conditions are observed, I have always found my own customers prefer these intruments to carbon transmitters; for the speech is loud, yet soft, and beautifully clear.

Another point is, that with magneto-telephones the company will be put to *far less expense* in the maintenance of the instruments than if they used carbon transmitters; for, to put it briefly, what can affect a ferro-type diaphragm?

In conclusion. When the Mutual Telephone Company have their system in full swing, they will naturally be delighted at the (almost) absence of disturbing noises on their lines. This they will ascribe to the metallic return. True to a certain degree, but not altogether. For when the middle of next year comes, permitting the free use to everybody of carbon transmitters, should the company then resort to these, I have the audacity to prophecy they will find the disturbing noises on their circuits increase remarkably.

J. S. Ross (Ross & Co.).

May 13th, 1890.

J. F. SCALES.—Your insulator, although mechanically ingenious, we do not hesitate to say is electrically as defective an arrangement as could well have been devised; everything is calculated to increase surface leakage, the crack in the porcelain, the long strap to hold the insulator down, the close bedding of the latter on the arm. We strongly advise you to abandon the patent, and before devising anything more of the kind to study the conditions requisite for an electrically good insulator, and to take advice from those who are competent experts on the particular subject.—EDS. ELEC. REV.